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HOW TO LOCATE INDIAN PLACES ON MODERN MAPS[1]

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In the collections of the Ohio State Museum, a manuscript recently came to light, which had never before been given attention. It turned out to be the private travel diary of the Rev. Johannes Roth, a Moravian missionary among the Indians in the American East. In this diary, Roth describes his journey, in the summer of 1772, by water, with Indian converts in canoes, from the Moravian Indian mission of Friedenshütten, near Wyalusing, on the North Branch of the Susquehanna, to Great Island, below present-day Lock Haven, on the West Branch. From here, the migration was continued overland, on foot and horseback, to the Allegheny River and, eventually, to their final destination, Friedensstadt (or Langundouténünk), a Moravian mission on the upper course of the Great Beaver, in Lawrence County, Pennsylvania.

Since not even the Moravian Archives at Bethlehem, Penna., possess a copy of this manuscript, its contents had been entirely unknown.

In this account of his day-by-day progress, the Rev. Roth mentions a number of Delaware (or Lenni Lenape) Indian names for Pennsylvania localities which, guided by their etymology, I have attempted to locate on the map. I am exclusively presenting here such Indian names as have never before been discussed, or even listed, for the state of Pennsylvania.

I am introducing each of the following place names in the spelling found in Roth's diary which, by the way, is in his own hand. He had profound knowledge of Unami, the leading Lenape dialect; hence, the names, as he heard them pronounced by his Indians, no doubt, conveyed to him a distinct meaning, which in every case is descriptive. Since, however, he jotted them down on the basis of his native German phonology, using, moreover, in some cases, his own individualized spelling (as he likewise does in his German), most of the names must first be rewritten in a form which permits their etymological analysis. The etymologies here following are derived from Brinton (1888), or Zeisberger's Dictionary (MS), or both.

DISCUSSION OF ROTH'S LENAPE PLACE NAMES

According to the diarist, his first night camp was only about eight miles downstream from Wyalusing in a location called, by his Lenape, *que nahlach quamique*. Only when writing *quen-nàllah-kamíke* can one attempt an etymological analysis: *quen-*, 'far, long'; *nallah*[*ih*], 'up the stream'; *kamíke*, indicating quality of soil, here, 'good soil.' This gives a meaning of 'good bottom land far upstream.' A location fitting this description appears, about eight miles below Wyalusing, on *U. S. Geol. Surv. Map*, Penna., Laceyville Quadrangle, under the name of 'North Flat,' across the river from Skinner's Eddy (fig. 1). 'North Flat' clearly expresses in English what the Indians meant to say in Lenape.

[1]Paper read before The Ohio Academy of Science, Section of Anthropology and Sociology, at its annual meeting at Kent State University, Kent, Ohio, on April 18th, 1952.

For the following night's camp site, about twenty-five miles below North Flat, the Lenape had the name of *Mehamakapuchküng*. When rewritten, *Mecha-máchk-apuchk-ünk*, the following etymology presents itself: *mecha-*, 'great, big'; *machk[e]*, 'red'; *-apuchk-*, 'rock, cliff'; *-ünk*, locative suffix, 'place where.' Meaning of the name: 'place of the big red cliff(s).' The Pennsylvania Guide (1940), page 362, mentions the "red cliffs that plunge into the stream," near that point, on the south bank of the North Branch, 25 miles below North Flat. The diary, moreover, refers to three islands, nearby in the river; they are shown on

FIGURE 1. Map section showing North Flat, across the Susquehanna's North Branch from Skinner's Eddy.

U. S. Geol. Surv. Map, Pennsylvania, Tunkhannock Quadrangle, where also the precipitous character of the south bank is clearly evident (fig. 2). According to White (1883), page 121 ff., these red cliffs are outcroppings of "red shale," which in this region is overlaid with a top stratum of "calcarious breccia."

Roth states that they made their next night camp below a place which he calls *Ehomatank*, adding, "that is, a fall." In fact, he applies this same name to a second cataract, not too far below the first, spelling, this time, *Ehomætank*. Not as far as I can see does either of the two forms mean 'a fall.' Hence I propose, although with some caution, to write, *Eh-ámæⁿ-tank*, which is conducive to the

following etymology: *eh-*, emphatic prefix, 'indeed'; [*wend*]*ámæn*, 'to fish with hook and line'; *-tank*, suffix of personal agency, 'he who does.' This would make the name mean, 'here, indeed, one fishes with hook and line.'

The place where, below the first of the two falls, they made that night camp was called by the Indians, *Woapagüchüng*. When written, *Woapak-giéchg-ünk*, the following etymology appears acceptable: *woapak*, 'a sycamore'; *giechg*[*i*], 'nearby'; *-ünk*, locative suffix, 'place where.' Meaning: 'place near the sycamore(s).' From various indications in the diary it can be inferred that both this cataract and the camping place 'near the sycamore(s)' were close to the site of present-day Exeter, near Pittston, Lucerne County; see *U. S. Geol. Surv. Map*, Pennsylvania, Pittston Quadrangle. One of these indications is Roth's remark that, during

FIGURE 2. Map section showing the "Big Red Cliff" proclivity on the south bank. and the three islands nearby.

the night, drunken visitors from "the Fort nearby" (most likely, Fort Wintermute) came into the camp, making a nuisance of themselves. Fort Wintermute had been built on a site covered today by the town of Exeter (Pennsylvania Guide, 1940, page 476).

Wiquetschuwik was the Lenape name, listed by Roth, for his camp site of June 15th; and, in parentheses, he adds the translation, "that is, the end of the big mountains" ("das ist der grossen Berge Ende"). Analytically, the name may be written, *Wique-'chtschuwik: wique-*, 'end of'; [*wa*]*chtschuw*[*ak*] (plural of *wachtschu*, 'a hill, mountain') 'the mountains'; *-ik*, locative suffix, 'place where.' Hence, the name means, 'place where the mountains end.' By adding, in his translation, the epithet 'big,' Roth evidently wished to be more explicit about the physiography of this camp site, which, on the basis of the day's mileage, can be identified as the spot near Catawissa (Catawissa Twp., Columbia Co.) where, on the left river bank, the Catawissa Mountains, running east-west, abut against

the bend of the Susquehanna (*U. S. Geol. Surv. Map*, Pennsylvania, Catawissa Quadrangle (fig. 3).

As the Lenape name of his camp site, on June 16th, Roth gives *Temamip-apuchko*. Analytical spelling, *Tem-òmep-ápuchko*, reveals the following components: *tem*[*iki*]-, 'single'; *ome-p*, 'came forth' (from *ome-n*, 'to come forth'); *-apuchk*[*o*], 'a rock, cliff.' Hence, the name means, 'rock (cliff) having come forth singly.' This description fits the topography at Danville (Mahoning Twp., Montour Co.) where across the Susquehanna, near Riverside (Rush Twp., Northumberland Co.) the powerful profile of lone Blue Hill dominates the view from the

FIGURE 3. Map section showing the 'end of the big mountains' at the bend of the North Branch near Catawissa.

river (fig. 4). This place, being the only one, downstream from Catawissa, fitting the name, may, therefore, be safely regarded as the camp site of June 16th (Singmaster, 1950, page 49, illustr.; *U. S. Geol. Surv. Map*, Pennsylvania Shamokin Quadrangle).

The camp site of June 19th was a place called *Ehendalawunsink*. I propose to write *Eh-end-alláuwun-s-ünk: eh-*, emphatic prefix, 'indeed'; *enda-*, 'where'; *alláuwin*, 'to hunt'; euphonic *-s-*; *-ünk*, locative suffix, 'place where.' Hence the name would mean, 'here, indeed, is a place where to hunt.' This location cannot be precisely identified; it is likely, however, that it was near the site of present-day Lewisburg (Union Co.). The "many white people" who came visiting the travelers point to the rich and early-settled farming district in which the town of Lewisburg

was laid out as early as 1785; while names such as Buffalo Creek, entering at Lewisburg, and White Deer, eight miles north, suggest good hunting. So does indirectly the fact that, near here, the well-known Oneida chief, Shikellemy, had his residence, still remembered as 'Site of Shikellemy's Old Town' (Pennsylvania Guide, 1940, page 544). See *U. S. Geol. Surv. Map*, Penna., Milton Quadrangle.

On June 25th, Roth mentions a night camp at *quename mennâhenna*. This name requires no rewriting since, in Roth's spelling, its etymology is quite clear: *quen-*, 'long'; *am[e]-*, 'indeed'; *menâchhen[a]*, 'island.' Meaning: 'very long island.' As evident from that day's mileage given by Roth, this can only have been Long Island, near Jersey Shore, 2½ miles below the mouth of Pine Creek

FIGURE 4. Map showing the 'cliff that comes forth singly': lone Blue Hill, at Riverside, across the Susquehanna from Danville.

(fig. 5). See *U. S. Geol. Surv. Map*, Penna., Williamsport, Quadrangle. The English name, 'Long Island,' is clearly a translation of the Lenape name.

The names now following apply to localities encountered by Roth on his overland travel which he began at Great Island, near Lock Haven, jointly with Ettwein and his party. Ettwein, however, with one exception, gives no Indian names in his official travel report, while his descriptions sometimes helped to identify Roth's Indian-named localities. This is true for the next name to be discussed.

Roth calls it *Lahallâwascutewi Sipüng*. To make its components discernible, it must be presented in the analytical writing, *La^{u}ha-l láw-asgote^{u}-wi-sip^{o}-ünk: lauha-*, 'middle of'; *l'láw-asgote^{u}*, 'a wide plain' (literally, 'it is in the middle [*leláwi*, 'halfway, in the middle']); *-wi-*, copulative suffix; *sip[o]-*, 'river'; *-ünk*, locative suffix. Meaning: 'where the river runs in the middle of a wide plain.' This name fits the description of the place such as given by Ettwein (Jordan, 1901, page 214): "July 14. Reached Clearfield Creek, where the buffaloes formerly cleared large tracts of undergrowth, so as to give them the appearance of cleared fields; hence the Indians called the creek Clearfield. . . . " Obviously, the

English name, 'Clearfield,' for both the creek and the settlement, is a translation of the Indian name given above (fig. 6). That is all the more plausible in view of the meaning of *l'lâwasgoteu*, 'a wide plain,' which, in *-asgol-*, contains the connotation of *asgask*, *askiwi* [*asgiwi*], meaning both 'raw' and 'green' (also note *askiquall*, a plural, meaning 'grass, herbs'). In brief, to the Lenape it meant 'an area cleared of undergrowth and, subsequently, while still in the raw, covered with green grass and herbs.' See *U. S. Geol. Surv. Map*, Penna., Clearfield Quadrangle.

FIGURE 5. Map section showing Long Island in the West Branch of the Susquehanna at Jersey Shore.

At a later date, Roth mentions a night camp in a region which the Indians called *Wachtschunglelawi awossijaje*. These are really three words, *Wâchtschünk lelâwi awôssijaje: wachtsch*[*u*], 'a hill, *mountain'; -ünk*, locative suffix, 'place where'; *lelâwi*, 'halfway, in the middle'; *awossijaje*, 'over, over there, beyond, on the other side, behind.' This makes the three words signify, 'place where there is a mountain halfway on the other side'; or, rather, 'where there is a mountain halfway between the one side and the other.' that is, 'a divide' between two river systems; in this case, between the Susquehanna and the Ohio.. This divide extends over Brady and Bell Twps., Clearfield County. From the combined reports of Roth and Ettwein it is evident that, in this mountain region, at "a spring, the first waters of the Ohio [Allegheny]," Roth had caught up with Ettwein, on July 19th. According to Ettwein's rather detailed information on the route of his advance,

on July 18th and 19th (Jordan, 1901, page 215), the most likely point on the divide, for the night camp of July 19th, appears to be near the source of the north branch of Mahoning Creek, in Brady Township, Clearfield County, close to present-day Salem. See *U. S. Geol. Surv. Map*, Pennsylvania, DuBois and Penfield Quadrangles (fig. 7).

Finally, there is a locality mentioned for which, quite exceptionally, Ettwein is the one who gives an Indian name (Jordan, 1901, page 217) that fits a situation

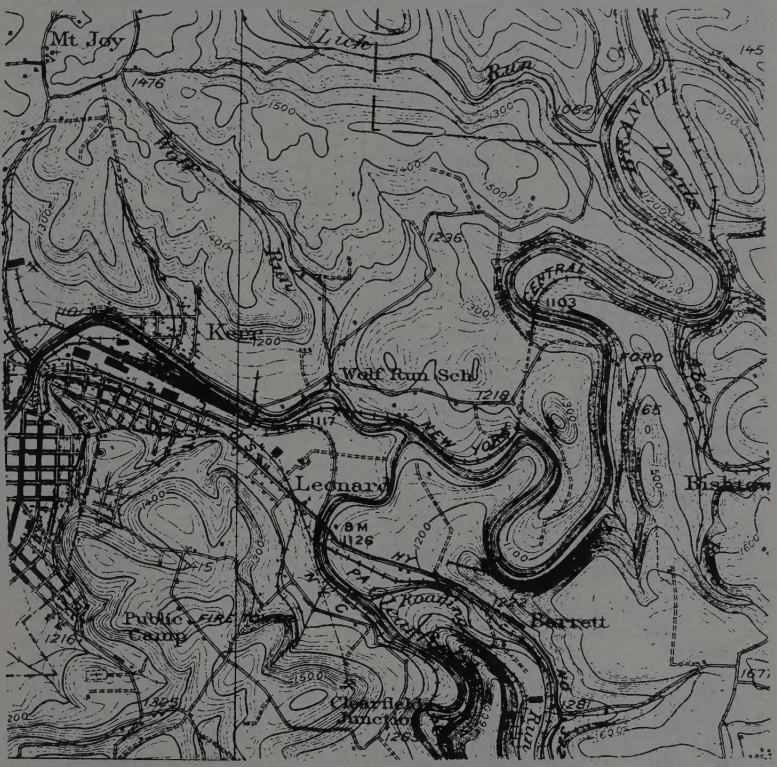

FIGURE 6. Map section showing the 'place where the stream runs in the middle of a wide plain': the area east and west of Clearfield Creek near its confluence with the West Branch of the Susquehanna. The settlement on the left is the eastern half of present-day Clearfield.

very well described in Roth's diary. On July 28th, Roth complains about "an incredible number of trees across the path . . . broken down by the storm . . . and always on our course." Ettwein, under date of July 27th, mentions as their destination a locality which he calls *Tschachkat*. So far, *Tschachkat* neither could be identified nor has the name been explained. With Roth's description of the storm damage in mind, however, a plausible explanation offers itself: *tschachkat* (or *tschachgat*) appears to be connected with *tschachg*[*achtin*], 'stump' (also note, *tschachg*[*ihilleu*], '[it is] torn off; broken'), thus giving *tschachgat* the meaning of

'something broken down; a windbreak.' According to Roth's travelogue, this windbreak must have been located south of Mahoning Creek, east of its confluence with Little Mahoning Creek, its tributary from the southeast, in Indiana County.

FIGURE 7. Map section showing part of the divide between the Susquehanna and Allegheny Rivers; especially note the stretch of the U. S. Highway [322] between Salem and Coal Hill School, which clearly runs on the ridge.

That storm damage, by the way, must have occurred some time in the past, for the Indians already had that name for the locality when Ettwein, on July 27th, designated it as his destination.

SUMMARY

A brief summary of the method followed in this study may be appropriate. As a *first* step, the etymology of each place name had to be established. In most cases, this was no simple matter because the names had been written down by Roth as he had heard the Indians pronouncing them, and with no attempt at separating the etymological components. As a *second* step, each meaning, tentatively accepted, was tested as to its accordance with the topographical features which it was supposed to describe, in the map area where it belonged. This map area, in each case, was determined by measuring off, with a Hamilton Map Measurer (Model No. 33), on the respective Quadrangles of the *U. S. Geological Survey Map*, Pennsylvania, the distances in miles from one camp site to the next, such as daily recorded in the diary. As a *third* and final step, conclusive confirmation of results so far obtained was sought, and occasionally derived, from pictures or descriptive passages in books.

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Zoology. *Alfred M. Elliott.* Appleton-Century-Crofts, Inc. New York. 1952. 669 pp. $6.00.

This textbook for courses in general zoology is in the new tradition that pictures zoology as a science, and as a biological science. It begins with a brief well-illustrated section relating basic physiological principles to principles of physics and chemistry. Then follows an excellent treatment of the invertebrates. The point of view taken deals primarily with principles, secondarily with anatomy, yet the latter is remarkably complete. The comprehensiveness of coverage, and the teachableness of the text result largely from excellent illustrating. Beautiful photographs, humerous cartoons, and a unique new type of instructive cartoon are employed liberally.

Over half of the book is devoted to the Chordates. However, this half includes summaries that make it a textbook of comparative zoology, of invertebrates and vertebrates. Furthermore, it is enriched by well-chosen information on physiology. Here again, principles are the first concern, and furnish a lead-off for handling anatomy. The material on heredity and embryology shows careful selection and gives an excellent perspective of the modern conceptions in these fields. The thread of evolution runs through every chapter, and is climaxed in a fine terminal chapter.

The text is printed in double columns per page, with topics and subtopics clearly outlined, and with important vocabulary in bold-faced type. A glossary is appended.

CHARLES D. HOWELL.

PEHR KALM'S DESCRIPTION OF THE PERIODICAL CICADA, *MAGICICADA SEPTENDECIM* L.[1]

From Kongl. Svenska Vetenskaps Academiens Handlingar, 17: 101–116, 1756. Translated by Esther Louise Larsen (Mrs. K. E. Doak) of Crown Point, Ind., and submitted for publication by Professor J. J. Davis, Purdue University, Lafayette, Ind.

INTRODUCTION

In 1749, a heavy infestation of the periodical cicada occurred in Pennsylvania. Pehr Kalm, who was visiting there, described in detail the insect in its 18th century surroundings. His paper was published in Kongl. Svenska Vetenskaps Academiens, Handlingar, 17: 101–116, 1756, under the title "Beskrifning pa et slags Grashopper uti Norra America" (Description of a type of Grasshopper in North America). Because of the misleading title, it is doubtful that many scientists are aware of the existence of this early report on the periodical cicada. Kalm refers to the insect as a *type* of grasshopper, but he also says that it may well prove to be a cicada. The annual cicada, which Kalm and his contemporaries heard, was thought to be a vagrant periodical cicada. Although he was not clear on the taxonomy of the insect, his sharp observations have given us an accurate account of the infestation.

Among the many flying insects in North America there is a species of grasshopper which seems to merit special discussion because of its extraordinary characteristics.

The English refer to this species as locust, the Swedes, gräshoppor. The Latin name may well be *Cicada, maxilla utraque lineis octo transversis concavis; alarum margine inferiore lutescents.*

This cicada would seem to be exactly the same species as that found in the Provence and Languedoc in France, which is illustrated and described by Mr. Reaumur in Memoires pour servir a l'Histoire des Insectes, T. V. *Mem.* IV. Tab. XVI. f. 1. 2. 5. 6. Many characteristics of the American insect are not noted in his description; thus it may prove to be entirely different.

The habitat of this insect is the greater part of North America where it occurs in Georgia, Carolina, Virginia, Maryland, Pennsylvania, New Jersey, New York, and New England. Later, when I travelled through the Land of the Iroquois to the large waterfall Niagara, I heard its squall in the woods daily, for no matter where it is it does not remain silent for long.

Before going further, I shall give a description of the insect's structure:

EDITOR'S NOTE: Here follows such a complete and lengthy description of the adult as to leave no doubt in the minds of 20th century entomologists that Pehr Kalm was describing the Periodical Cicada, *Magicicada septendecim* L. Some concluding statements are here reproduced.

The length of the entire insect including the wings is 1 digit, 5 lines. The length of the wing is 1 digit, 1 line, the maximum width 4 lines. There is some variation in size.

Almost directly in the center of the abdomen, but a little toward the back, there is a dart with which the insect breaks the bark of trees. It extends backward lying close to the abdomen. This shiny, brown needle-like appendage is 3½ lines long. It is grooved lengthwise on the lower surface, and is shaped like a very sharp lancet on the end.

There are two short thick darts in the end of the tail, which are sharper near the end and slightly hairy. The insect may use these to lay its eggs since the one above was used for making holes in bark.

[1]This translation of Pehr Kalm's observation on the periodical cicada made about 200 years ago is published now because of its unusual and timely interest. The brood referred to will reappear in eastern and central states in 1953.

These insects are extraordinary. They appear in astounding numbers with indescribable suddenness on certain years. Between the infestations years pass in which only an occasional insect is heard.

I happened to be in America on one of the years when a heavy infestation of this insect occurred. I, therefore, had an opportunity to study it closely.

In 1749, on the 22 of May, new style, these locusts or grasshoppers appeared in dreadful quantities in Pennsylvania. They had been lying in holes in the ground throughout the winter and spring like *Eurcae*, but on this day they crept out of their winter coats and came forth in summer dress. A tree could scarcely be found, in either forest or orchard, whose trunk was not entirely covered with them. Some had emerged from their pupal cases, others were emerging so they were half in and half out. Some had begun to try their wings. It was remarkable that on the previous day, that is the 21st of May, there were none. I had spent the two previous days in the woods collecting plants and insects, but I had not seen a single locust. Others had the same experience. The insects appeared simultaneously throughout the vicinity. On the first day of their arrival, I saw them in the woods along the Schuylkill River, and at tradesman P. Kock's country place which lies 13 miles from the river. It was said that the insects, which were still silent, would soon make such a din that one could scarcely hear because of them. This, I later found to be true.

For seventeen years these insects had not been seen, now they appeared in fantastic quantities throughout the land. Prior to emerging, the nymphs dwell in holes in the ground. I had often seen nymphs in the openings of these holes, but I had no idea what type of creatures they would become.

They usually come out of their holes at night and climb trees and the stems of plants. The nymphal cases, which split on top as the insects emerge, are discarded, but remain attached to trees and plants until blown to the ground or washed away by rain. The ground underneath the trees is often covered with discarded pupal cases. Newly emerged insects dry their wings before attempting flight. Chickens are greedy about the insects just as they creep out of their holes. They are especially appetizing to birds at this stage. This may be the reason why the Creator has foreordained that they should appear at night, so they may not be destroyed by birds before they have reached the stage where they can fly away. I do not know if they dig the holes themselves in which the nymphs lie, or if they avail themselves of those dug by various types of earth boring dung beetles. They burrow the ground, no matter how hard, wherever the excrement of horses is found. It is highly unlikely that dung beetles account for all the holes utilized by these insects.

On the 25th day of May the insects were heard in the trees. It should be noted that they rarely ever are seen on the ground. They now made such a roar and din in the woods they they could be heard for great distances. If two persons happened to meet they would have to shout in order to hear each other. If they were any distance apart it would be necessary to strain the voice to capacity in order to determine what was being said.

The secretary to the government, Mr. Peters, stated that the day the insects emerged, a large number in the process of working their way upward were found at a depth of 12 feet by a man who was digging a pit. Mr. Willing, who was mayor of Philadelphia that year, said he happened to be in the country when the insects were appearing. He saw, with his own eyes, an abundance of these insects 4 feet below the surface where a pit was being dug. They were busy burrowing their way upward toward the light. The hole they make is smooth and round as if it had been made with an auger. Their food habits are not known, but it is believed that they eat soil during the nymphal stage. After they emerge they have not been seen eating anything.

The general opinion is that these insects appear in these fantastic numbers

every seventeenth year. Meanwhile, except for an occasional one which may appear in the summer, they remain underground.

There is considerable evidence that these insects appear every seventeenth year in Pennsylvania.

In the Wikaco parish register for the year of 1715, the Swedish dean and rector, Mr. And. Sandel, who later became Dean of Hedmora, made the following entry:

"During the month of May, there came out of the ground a particular fly or grasshopper which the English call locusts. They appeared everywhere even on hard roads. A shell completely covered the mouth, body and feet. It seems strange that they could make a hole through the ground while covered with a shell. After coming out of the ground they emerged from their shells, and flew away settling in the trees. There they made an extraordinary sound from morning 'til night. Since they were so numerous throughout the country, cowbells could scarcely be heard in the woods because of the noise. The insects slit the bark of the branches and trees and deposited the worms. In spite of this the trees did not show any injury the following year. Swine and chickens eat the insects. The heathens eat them, especially just after they emerge. The newly emerged insect is fried a little and then eaten. This may be the same type of insect as that which John the Baptist is said to have eaten. The insects lived until June and then they died."

Dean Sandel served the Wikaco congregation from and during the year 1702 to the end of June, 1719, but with the exception of 1715, no mention is made of grasshoppers or locusts. He surely would have mentioned them again had they appeared in this unusual fashion. The church register shows that Dean Sandel was meticulous in keeping records. All of the old Swedes said there had been no infestation for many years before or after the one mentioned above.

Seventeen years later, in the year 1732, the next infestation occurred. The Swedish church register did not enlighten me. It ignored this and much else. The current rector, it would seem, was not very observant. However, Mr. Benjamin Franklin gave me some records, which were kept over a period of years in Philadelphia, by an Englishman named Breintnal. His observations on the subject for the year 1732 are as follows: "Early in May, the locusts began to come out of the ground. The 12th of May, they were still coming and there was an indescribable quantity. By the 19th they were strong enough to mate, after which they began to bore into the trees and lay their eggs. On the 22nd they flew about in large swarms. On the 24th locusts were still coming out of the ground, but by June 13th very few remained."

Breintnal began his observations at the beginning of the year 1731, and finished them the 11th of November, 1745, when he pitifully ended his days. Although he was exceedingly observant during all this time, and in complete charge of all his faculties, no other mention is made of these locusts or grasshoppers. The Swedes and others insist that, with the exception of an occasional one here and there in the woods, they were not seen in any quantity until the 22nd of May, 1749, when they appeared in large swarms.

I can not say, from my own observations, how long they remained in Pennsylvania in these dreadful numbers, as I set out upon a journey, north to Canada, at this time. According to all reliable sources they continued in large numbers for about six weeks and then disappeared. The observations of Dean Sandel and Breintnal are in agreement with this.

The insects slit the fine moist bark of small branches with the ovipositor, which later penetrated deep into the branch, depositing eggs or other material. As a result, large numbers of branches dried up. A type of mucus is deposited on the branch by the ovipositor at the time of penetration. Although the bark on the young twigs of nearly all trees may be slit, the insects seem to prefer that

of oak and apple. The ovipositor can not penetrate thick rough bark. The year following the infestation, large quantities of branches died and fell to the ground because of this bark injury. I could detect no other damage, but some said entire trees dried up. This might well happen to young trees where all the bark is tender and can be penetrated by the ovipositor. Permanent damage might result if too many young twigs on a large tree were destroyed just before a hot spell, or a long dry one.

It is generally believed that the insect shreds the bark in order to deposit eggs. I can not say for certain if this is the case, although it would seem to be so. My departure from Pennsylvania, just after the insects had emerged and prior to the completion of their cycles, did not permit me to investigate. Neither larvae nor pupal cases have been observed following the infestation. What has become of them? It would seem that on the same year or the succeeding one, pupal cases would appear in at least the same number as the parent insects. We may assume that each insect lays more than one egg, yes, even hundreds, if it resembles other insects. Even if each individual layed only three or four eggs and all of these hatched at once, the locality suffering from an infestation would be overwhelmed. In a short time, trees and plants within range would be completely destroyed. However, the Almighty Creator has other plans for them, and one rarely sees even a single pupal case in the year following the infestation. In the light of these observations, might it not be possible that they go deep into the ground and feed there for a time before becoming dormant cocoons or pupae. After a definite period of time, or under favorable conditions, might they not wake up and come forth from their hiding places? There is still much to be learned about the life histories of insects.

During the period of infestation, Indian women and children collect the insects in baskets and carry them home. They are then fried and eaten as a delicacy. Although the savages eat these insects, they are not the same as those which were eaten by John the Baptist in the desert. This can be seen from the observations of Dr. Hasselqvist, and in a letter from Architater and Knight von Linné to Joh. Flodman. The letter is included in his disputation, "John the Baptist's clothing and food," and an illustration of the grasshopper of the East is given. Obviously people in various parts of the world eat insects. The practice is neither strange nor unusual, unnatural nor impossible. The Indians have a related custom. When young wasps are still in their cells and large enough for small wing development, but still white in color, they are eagerly collected by the savages, who fry them and then eat them with great relish.

Various creatures such as swine, chickens and birds of the forest, particularly the shrike, are greedy for these grasshoppers. Chickens would not fly to their roosts at night when they were emerging, but stood and waited on the sod in order to seize them as they came out of hiding.

A peculiarity of these insects is that they do not emerge simultaneously in such shocking quantities in all places. For example, the year the whole of Pennsylvania was swarming with them, not a single one was heard of in New England. This was also true of other localities. When I left Pennsylvania in May, 1749, I was afraid my ears would be ruined by the noise and the disturbance they made in the trees. The same hum and din reverberated in the woods in part of New Jersey, but as I travelled toward New York the noise diminished. Beyond Albany, I heard only an occasional one, and I frequently travelled a whole day without hearing any. The inhabitants of Albany had not heard any more than usual. It was nine years since their last heavy infestation.

The following year, 1750, during April, May and June, I travelled through large sections of New Jersey and Pennsylvania. Frequently, I travelled all day through the forests without hearing a single insect although I listened carefully for them. Where had the insects gone that had filled all these woods a year ago?

In travelling to New York from Trenton, I met an old man of that community, who said he had not heard one of these insects that entire spring. Although according to him, they had been more numerous than the leaves the previous spring. That same summer I tavelled through most of the province of New York to Albany and the Land of the Iroquois, I heard only an occasional humming in the trees. An infestation occurred in New England in the spring of 1750. Just as the insects were emerging, but before they had dried their wings, there was a heavy night frost which killed most of them. Consequently the noise, in the woods that summer, was not as loud as usual.

Several old Swedes living in Pennsylvania and New Jersey said that the year following these infestations was marked by an infestation of leafworms. Because of these pests the forests were entirely leafless during the month of June. They concluded that the worms came from the eggs which had been layed under the bark of the trees by the grasshoppers the previous year.

If such an infestation of worms always occurs on the year following the grasshopper infestation, I can not say. I found nothing on it in the Swedish church records, in the observations of Breintnal or other writings. It is true that this did happen during my visit to America. In May, 1750, such astounding quantities of leafworms appeared on the trees in Pennsylvania that I had never seen the like. At another time I shall have the honor of presenting to Kongl. Vetenskaps Academien a complete description of them. I shall show that these worms can not claim the grasshoppers as their parents but belong to an entirely different group. I collected some of the worms and fed them leaves until they had undergone metamorphosis. Out of these worms came a species of *Phalaena*, not grasshoppers. The handiwork of the Almighty Creator is easily recognized in the lives of these small creatures.

World Population and Future Resources. *Paul K. Hatt*, Editor. American Book Company, New York. 1952. xviii+262 pp. $3.50.

The recurrent question about the adequacy of the material resources of the earth to satisfy the needs and wants of a steadily increasing population is here re-examined by twenty authors in as many chapters. Under four major headings: The Population Factor, Food Resources, Material Resources of Industry, and Energy Resources, the numerous aspects of this age-old but ever-new problem are reviewed and summarized in a brief presentation of only 262 pages.

In the section on population five different authors discuss briefly, if not definitively, the most important features of population such as absolute numbers, densities, birth rates, death rates, natural increase, and the differences among peoples in many parts of the world in respect to these demographic phenomena. The controversial issue of birth control is mentioned but receives very little attention.

The situation in respect to food resources is presented by six authors in six chapters in part two and all agree that productivity of the land has declined in many parts of the world, that the limits on production are far in the future, and that a very large increase of food can be expected by improved land management policies, the more effective use of the water resources, by the application of modern science and technology, and by an attack upon the cultural drag of backward practices in agriculture.

In part three four authors survey the material resources of industry to be derived from the land and the sea and note the increasing demands for industrial and structural materials as our power-using economy becomes more and more complex.

In part four, five authors examine the power situation, express concern about the adequacy of the fossil fuels to meet the long-term needs of a modern industrial society, report the facts and the hopes in respect to atomic power, and point out the limitations and the prospects in the utilization of solar energy.

Condensed in this small book is a carefully organized statement about the adequacy of the resources of the earth to satisfy the requirements of a growing population in respect to food, clothing, shelter, and the higher wants of people in different cultural areas of the world.

GUY-HAROLD SMITH.

PLEISTOCENE HISTORY OF A PART OF THE HOCKING RIVER VALLEY, OHIO[1]

WILLIAM M. MERRILL
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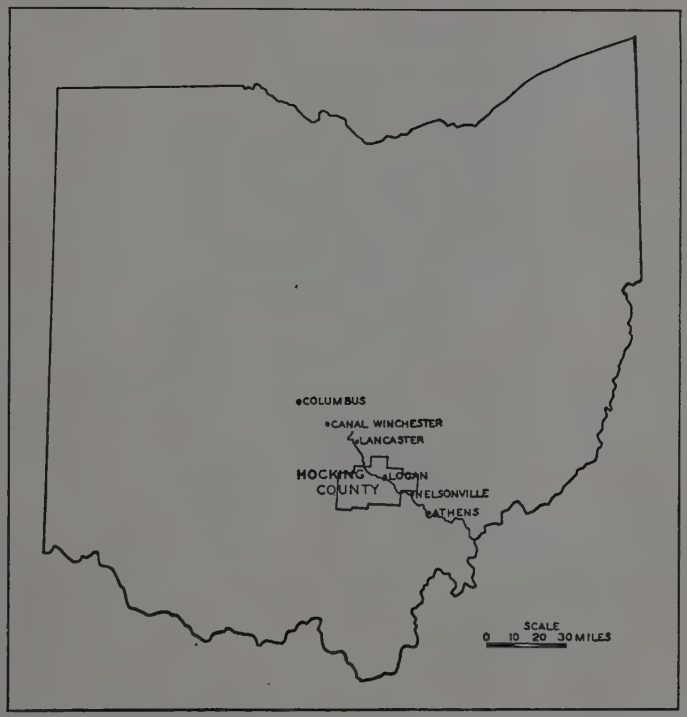
Drainage modifications caused by glaciation in the Ohio River basin have been the subjects of numerous papers since late in the nineteenth century. Tight (1900, 1903) and Leverett (1902) were the first to present a coordinated picture of the pre-glacial drainage and the successive changes that occurred as a result of the several glacial advances into Ohio. Many shorter papers, by the same and other



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writers, were published before and after these volumes. More recently, Stout and Lamb (1938) and Stout, Ver Steeg, and Lamb (1943) presented summaries of the drainage history of Ohio. These are based in part upon Tight's work but also introduce many new facts and give a more detailed account of the sequence of

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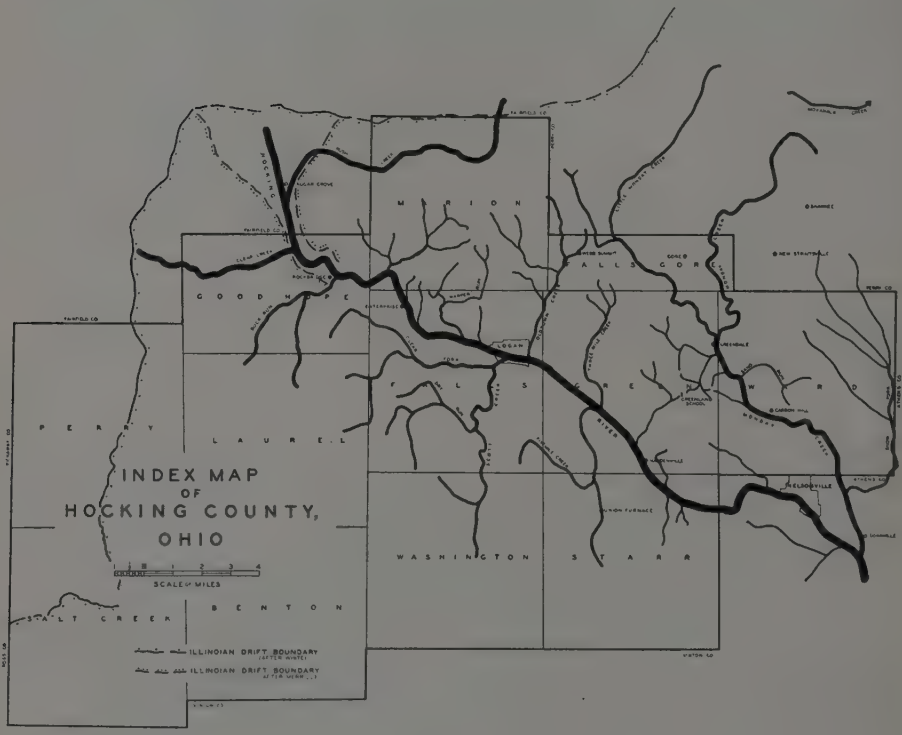
drainage changes and their causal factors. The bulletin published by Stout, et al. (1943, pp. 98–106), includes a comprehensive bibliography of the literature through 1942.

Evidence for four major stages of drainage with intervening glacial stages has been recognized in Ohio by Stout, et al. (1938; 1943). These stages have been summarized in columns 1–4, table 1. According to these writers (1938, pp. 66, 73, 76, 81; 1943, pp. 63, 83, 87, 96), all of the stages are represented in the Hocking Valley. The Hocking Valley chronology and the evidence presented by Stout and



his co-workers for the several stages in Hocking County are included in columns 5–9, table 1. Figures 1 and 2 are index maps on which the locations of Hocking County and the Hocking River (fig. 1) and the Hocking drainage in Hocking County (fig. 2) are shown. Detailed studies of the Valley by the writer were made northwest from the old divide southeast of Haydenville to the Fairfield-Hocking County line (figs. 2, 3).

Topographic maps on which portions of the Valley in Hocking County appear include the Lancaster, Logan, and Zaleski quadrangles. Parts of some of the important tributaries appear on the New Lexington and Athens sheets.

ACKNOWLEDGMENTS

The writer is indebted to Dr. J. Osborn Fuller and Dr. Richard P. Goldthwait, both of Ohio State University, for helpful advice in the field and for their critical reading of the manuscript of this report. Dr. George W. White and Dr. Paul R. Shaffer, University of Illinois, also contributed valuable criticism of the manuscript. Dr. Myron T. Sturgeon, Ohio University, discussed several of the field problems with the writer. The Division of Geological Survey, Ohio Department of Natural Resources, financed the field work of which the study of this problem was a part. A grant from the University of Illinois Graduate Research Board was used to pay the cost of drafting the illustrations.

TABLE 1

Drainage chronology of southeastern Ohio and the Hocking River Valley according to Stout, Ver Steeg, and Lamb (1938; 1943).

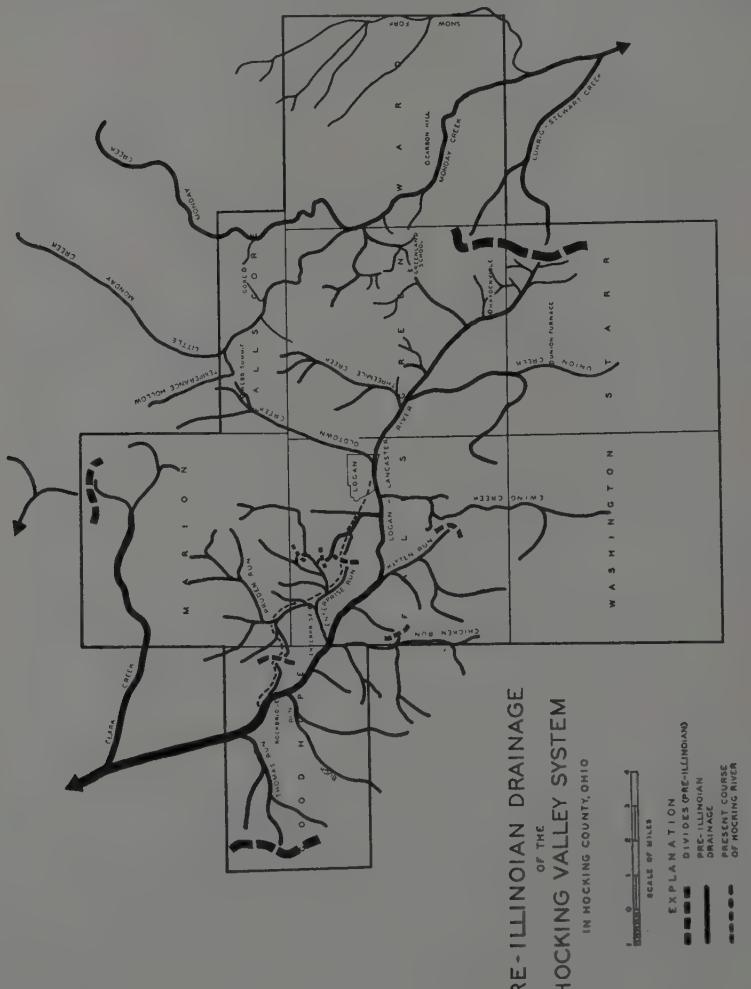
SOUTHEASTERN OHIO				HOCKING VALLEY				
(1) DRAINAGE STAGE	(2) AGE	(3) CLOSED BY	(4) RESULTS	(5) HOCKING VALLEY STREAM	(6) RESULTS IN HOCKING VALLEY DRAINAGE SYSTEM	(7) EVIDENCE IN HOCKING VALLEY DRAINAGE SYSTEM	(8) DIRECTION OF FLOW	(9) LOCATION OF HEADWATERS
Post-Wisconsin	Recent		Incision of valleys into Wisconsin valley trains	Hocking River	Incision of present valley into Wisconsin valley train	Present drainage system	SE	In glacial drift NW of Lancaster
Wisconsin	Wisconsin	Ice retreat	Deposition of valley trains; diversions; reversals	Glacial drainage	Diversion of stream from old valley into gorge from Rockbridge to Logan; deposition of valley train	Low terraces of Wisconsin outwash	SE	In glacier near Lancaster
Post-Illinoian	Sangamon	Wisconsin glaciation	Incision of valleys into Illinoian valley trains	Haydenville River	Erosion of Illinoian outwash completed cutting of gorge SE of Haydenville	Pre-Wisconsin valley cut into Illinoian outwash; gorge SE of Haydenville	SE	In glacial drift NW of Lancaster
Illinoian	Illinoian	Ice retreat	Ponding of Deep Stage drainage; deposition of valley trains; many diversions; reversals	Glacial drainage	Deposition of valley train; reversal of direction of flow in valley from NW to SE; development of Monday Creek; initial cutting of gorge SE of Haydenville	High terraces of Illinoian outwash sloping SE	SE	In glacier near Lancaster
Deep	Interglacial (Yarmouth?)	Illinoian glaciation	Deep incision of valleys below Teays valley floors	Lancaster River	Cutting of deep valley now filled with later glacial outwash	Elevations on buried bedrock floor of Hocking Valley and in abandoned valley segments	NW	In divide SE of Haydenville
Pre-Illinoian glacial	Kansan (?)	Ice retreat	Ponding of Teays system; deposition of boulders, gravel, sand, and Minford silt on Teays valley floors; many diversions; reversals	"Finger" lakes	Ponding of Hocking River NW of divide SE of Haydenville	Minford silt on remnants of valley floor of Logan River		In divide SE of Haydenville
Teays	Pliocene-Early Pleistocene	Pre-Illinoian (Kansan?) glaciation	Development of a mature drainage system	Logan River	Development of the original Hocking Valley drainage system	Remnants of main and tributary valley floors valley restrictions; barbed tributaries; widening of main valley to NW from gorge SE of Haydenville; abandoned valley segments	NW	In divide SE of Haydenville

LOGAN RIVER (TEAYS STAGE)

According to Stout, et al. (1938, p. 66; 1943, p. 63), during the Teays (preglacial) stage, the Logan River (fig. 3) flowed northwest through the present valley from the divide near Haydenville in northeastern Starr Twp., Hocking County, as far as Logan. From Logan to Rockbridge (figs. 3, 6), it flowed about one mile south of the existing Hocking Valley in what are now the valleys of Clear Fork and a tributary to Buck Run, re-entering the present valley at Rockbridge. Evidences for the existence and course of this early stream are the restriction of the present valley at the position of the old divide southeast of Haydenville; widening of the valley to the northwest, opposite to the direction of flow of the Hocking River; numerous barbed tributaries; and the presence of an old valley segment, now filled with glacial gravel, from Logan to Rockbridge. These writers

(1938, p. 66; 1943, p. 63) also point out the existence of old floor levels covered with "Minford or other silts" near Union Furnace at 800 feet, near Haydenville at 780 feet, at Webb Summit at 790 feet, and near Logan at 770 feet (fig. 3).

Re-examination of these localities by the writer suggests that there are no floor levels present that are residual from the final Teays Valley. Although good exposures of the material in the divide at Webb Summit are present in a railroad cut and supplementary auger borings were made, no "Minford or other silts" were found in this locality. Residual mantle on bedrock of Pennsylvanian age underlies the surface. In the vicinity of Haydenville, the only point which



approaches the elevation noted by Stout (780 feet) and which might conceivably be underlain by Minford silt is in the NW ¼ sec. 13, Green Twp., about one-half mile north of the town. No rock floor is exposed there, and the material underlying the surface, examined in auger borings, is glacial gravel. On the basis of its lithology and the surface elevation (table 2; fig. 5; the gravel is identified as Illinoian. Several rock terraces overlain by gravel exposed west of Logan on the south side of the Hocking Valley in SW sec. 10 and SE sec. 9, Falls Twp., are believed to be the features "near Logan" interpreted by Stout to be Logan River floor levels. The rock terraces are cut in the Black Hand sandstone and in every case, the rock surface is stratigraphically very close to the top of the Black Hand. Detailed mapping of the bedrock by the writer showed that the east flank of a depositional nose of the Black Hand crosses the Hocking Valley in this vicinity. The surface of the Black Hand here dips steeply eastward, passing under cover at Logan. The rock terraces conform in slope to this eastward dip and do not slope northwestward as would be expected if they were floor levels of the Logan River. It is apparent that they are rock-defended terraces cut into the Black Hand by a pre-Illinoian river, but probably not representing the ultimate floor level of that stream. The gravel which now caps these terraces is Illinoian in age.

Other localities, similar to those enumerated by Stout, that might furnish information concerning the Teays drainage history in this area also were examined by the writer. A railroad cut through the low divide (about 780 feet) at Gore exposes bedrock overlain by residual mantle. No rock exposures are present at the divide (830 feet) between the headwaters of Threemile Creek and Little Monday Creek (sec. 24, Green Twp.) or at the divides (790 feet and 830 feet) near Greenland School in eastern Green Twp., but examination of the exposed mantle at these places indicated the surfaces to be underlain by residual soil rather than transported materials of the character of the Minford silt.

It could be argued that these low divides at Webb Summit, Gore, the headwaters of Threemile Creek, and near Greenland School represent final floor remnants of tributaries to a stream developed during the Teays erosion cycle in the Hocking Valley. However, there is evidence to show that these low divides were established by a series of stream piracies which took place in succession during, not at the close of, a pre-Illinoian cycle of erosion.

These divides are located between tributaries to Monday Creek and tributaries to the Hocking River (fig. 2). Monday Creek and its tributaries are parts of four distinct early drainage systems (fig. 4), three of which were tributary to a northwestward-flowing stream in the Hocking Valley northwest of Haydenville and one of which was tributary to a southeastward-flowing stream in the Hocking Valley southeast of Haydenville. The divide between the two major streams (fig. 4), as determined from the location of the highest ridge now present and from the dendritic drainage patterns, crossed the Hocking Valley southeast of Haydenville; followed the present divide north and east to cross Monday Creek Valley east of Carbon Hill; extended north through central Ward Township and east of New Straitsville and Shawnee in Perry County to join the present Muskingum (Moxahala Creek)-Hocking River divide.

Figure 2 shows the existing streams in this area. Figure 4 is a sketch of the early streams with the present drainage superimposed. Stream names used in the text are taken from these figures. It is impossible to state the time at which the old streams shown on figure 4 existed, other than to say that it was during an early stage of a pre-Illinoian erosion cycle.

Lake sediments are present in the bottomlands of all the valleys (figs. 2, 4), including Monday Creek, that record lakes that occupied them during Illinoian and possibly Wisconsin glacial stages. Elevations of Illinoian gravel terraces in the Hocking Valley near the mouths of Oldtown Creek (794 feet; 805 feet), Threemile Creek (796 feet) and the stream near Greenland School (778 feet) indicate

the approximate height of the gravel fill which must have partially blocked these streams during Illinoian glaciation.

Stout, et al. (1938, un-numbered figures, pp. 71, 77; 1943, maps facing pp. 78, 86), imply that Monday Creek in its present form was established as a result of Illinoian glaciation. However, the drainage changes through which the present system came into existence must have occurred prior to the Illinoian stage. The low divides which exist between tributaries to Monday Creek and the Hocking

EARLY DRAINAGE
NORTHEAST HOCKING COUNTY, OHIO

River must have been present during the time that lakes occupied the valleys. Outlets into the Hocking must have been maintained throughout the time that the lakes existed. Had the lakes risen sufficiently to submerge the low divides and flow into Monday Creek, the Hocking would have been diverted into Monday Creek. Illinoian terrace gravels that would be abundant along the valley walls of Monday Creek if such a diversion had occurred are not present.

To one familiar with the history of southeastern Ohio drainage outlined by

Stout, et al. (1938; 1943), the possibility remains that Monday Creek and the low divides between it and the Hocking might have originated when the Teays River was blocked by a pre-Illinoian glacier and lakes occupied the valleys of the Teays system. The absence of Minford silts in the region and the fact that the Hocking flows in its present valley, not through Monday Creek Valley, make this possibility an unlikely one.

An alternate explanation is that Monday Creek originated and the low divides became established through a series of stream piracies that were probably independent of glacial episodes in Ohio.

The initial piracy in the sequence must have taken place when Carbon Creek (fig. 4) cut through the major divide near Carbon Hill to begin the reversal of the direction of flow of a tributary to Greenland Creek. Progressive reversal resulted in the capture of Sand Run and then the entire headwaters of Greenland Creek. The length of time that has elapsed since this piracy occurred is indicated by the fact that, except where it is complicated by the entrance of tributaries and by the presence of lake sediments, the valley of Monday Creek widens at a more or less uniform rate from its junction with Sand Run through the old divide toward its junction with Snow Fork.

The second piracy must have been that which occurred when a tributary of Gore Creek (fig. 4) captured a tributary of Webb Summit Creek in sec. 28, Falls Gore Township. Progressive reversal of this tributary resulted in the diversion of the headwaters of Webb Summit Creek into Gore Creek. This piracy is believed to have occurred prior to those outlined below because Little Monday Creek Valley has since been widened at the point of capture so that it conforms to the valley widths above and below. The capture left at Webb Summit the low bedrock divide which separates Oldtown Creek from Little Monday Creek (fig. 2). Altitude of this divide before the railroad cut was made was probably a little over 800 feet.

A third piracy took place in Section 36, Falls Gore Township, when one of the tributaries in the captured headwaters of Greenland Creek pirated a tributary of Gore Creek and reversed its flow as far as Gore, at which point the waters of Monday Creek northeast of Gore were captured. This established the present course of Monday Creek, the capture leaving the low bedrock divide which now exists at Gore. Altitude of this divide before the railroad cut was made was probably a little over 780 feet.

Following the piracy of the headwaters of Monday Creek, Maysville Run (fig. 4) captured and reversed a northwestward-flowing tributary to Gore Creek. This ultimately resulted in the capture of the headwaters of Little Monday Creek from Gore Creek, and the present course of Little Monday Creek was established. The low divide between Threemile Creek and Little Monday Creek (fig. 2) gradually migrated southwestward to its present position in sec 24, Green Township, as reversal of Threemile Creek headwaters continued to the stage now developed.

The probability that these piracies occurred over a period of time rather than simultaneously indicates that the low divides do not represent remnants of the final floor levels of tributaries to the Logan (Teays) River, as suggested by Stout and his co-workers.

The lack of evidence for a well-defined floor level for the Logan River in the Hocking Valley removes a surface of reference from which a subsequent Deep Stage stream could be affirmed as the agent which cut the deep bedrock valley that exists under the glacial gravels. Without such a surface of reference, it is also difficult to measure the amount of valley cutting accomplished by a Deep Stage stream, if such existed.

PRE-ILLINOIAN GLACIAL STAGE

Stout, et al. (1938, pp. 69–70; 1943, p. 78), state that the Teays system, including the Logan River, ponded when pre-Illinoian (Kansan?) glaciation blocked the main

stream and its tributaries. Cited evidence for this is the presence of the Minford silt, interpreted as a lacustrine deposit, at many localities in eastern and southern Ohio. The mineralogical composition of the Minford, especially the high percentage of sericite, led the writers (Stout and Lamb, 1938, p. 65) to believe that the material was carried into Ohio from the Piedmont area to the east by the Teays River and deposited on the floors of the blocked Teays streams. If Minford silt were present in the Hocking Valley, it would indicate that a current must have existed flowing from the main Teays River into the Logan River during the time the Teays was blocked. The presence of such a current would imply that an outlet to the east for the streams dammed in the Hocking drainage basin must have been in operation at this time. There are two possible locations for such an outlet; one into the Monday Creek system over one of the low divides discussed previously; the other over the col which must have existed in the divide southeast of Haydenville at the site of the present gorge (figs. 2, 3). The existence of such an outlet would be a significant point in the drainage history of the entire region and would suggest that the Logan River, if such existed, might have been reversed at this time rather than as a result of Illinoian glaciation. However, the present courses of the streams and the lack of evidence for the erosion that would have resulted had all or part of the Teays drained through the Monday Creek system make it unlikely that an outlet operated through it. The lack of Minford silts at the localities previously discussed, especially those near headwaters of tributaries, makes it equally unlikely that the lakes existed here and therefore no outlet is required over the Haydenville col. It therefore seems probable that no outlet for the Teays operated through the Logan River and that the River was not reversed at this time.

LANCASTER RIVER (DEEP STAGE)

After the pre-Illinoian ice block which dammed the Teays system had disappeared, the Hocking Valley again was occupied by a northwestward-flowing stream, the Lancaster River (Stout, et al., 1938, p. 73; 1943, p. 83). According to these writers, it took the same course as the Logan but cut the valley much deeper. The conclusion that the Lancaster incised its valley below the level of the Logan River floor was based largely upon the erroneous assumption that rock terraces and low divides in the Hocking River drainage system are remnants of the floor of the Logan River.

There is no well-defined evidence for two pre-Illinoian cycles of erosion in the Hocking Valley. If a Teays stream (Logan River) occupied the valley and was dammed during a pre-Illinoian ice advance into Ohio, the evidence was destroyed or buried during the Deep Stage and subsequent episodes. It is possible that there was no significant halt at the end of a first (Logan) cycle and that the Teays and Deep Stage cycles identified elsewhere in Ohio were a single pre-Illinoian cycle in the Hocking Valley.

Stout, Ver Steeg, and Lamb (1943, p. 83) cite four well records (table 2) to show that the bedrock floor of the Lancaster River slopes to the northwest. However, there is no assurance that the depths obtained from these wells represent the deepest part of the valley. The wells may have penetrated the old valley wall. The writer examined all of the pertinent records for northwestern Athens County, Hocking County, and Fairfield County as far north as Lancaster that were available in the files of the Geological Survey of Ohio and the Ohio Water Resources Board in the winter of 1949–1950. Only a very few wells penetrate bedrock and the irregularity of the elevations obtained make it obvious that many of those that do are on the old valley wall rather than in the valley bottom. The elevations listed in table 2 and shown on figure 5 include those cited by Stout, Ver Steeg, and Lamb as well as the few additional ones obtained by the writer. For each locality where more than one well penetrated bedrock, only the lowest eleva-

tion is given. For the Floodwood (Athens County) elevation, the figure is based upon the lowest well bottom, but the well ended in gravel rather than bedrock.

The inconsistency of the Sugar Grove and Enterprise figures is undoubtedly because the wells from which they were taken are located on the buried valley wall rather than in the channel of the old stream. The figures indicate that the slope is probably to the northwest, but much more detailed data, such as might be obtained from a geophysical survey, are necessary before final conclusions can be drawn.

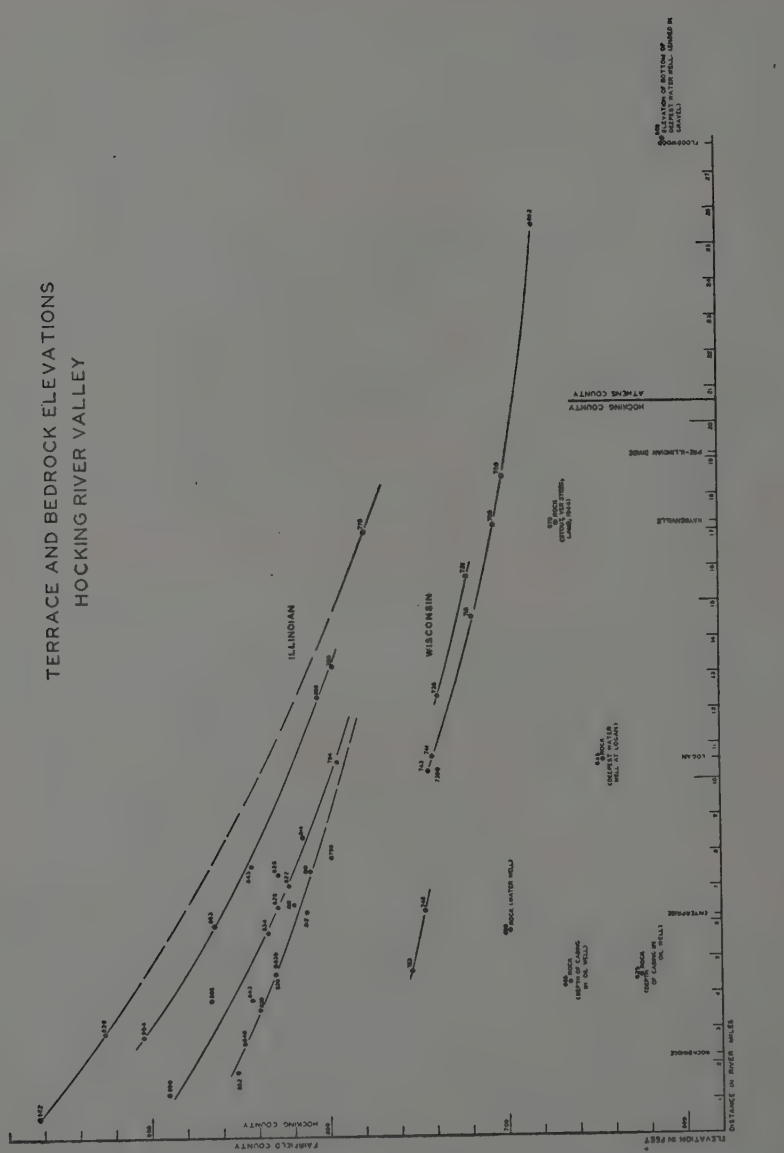
TABLE 2

Some elevations on the bedrock floor and terrace surfaces and indicated thickness of glacial fill in the Hocking Valley. (See also Fig. 5.)

[illegible] OF WELL	ELEVATION OF BEDROCK VALLEY FLOOR	ELEVATION OF [illegible] ILLINOIAN TERRACE	ELEVATION OF HIGHEST NEARBY WISCONSIN TERRACE	ELEVATION OF [illegible] LEVEL (estimated from topo. map)	THICKNESS OF FILL
Floodwood (section 3, York Township, Athens County, SE of Haydenville divide)	Below 610 feet. (Deepest well ended in gravel)	720 (?) feet (Elevation projected 11 miles from NW of Haydenville divide)	678 feet (Elevation projected 2 miles from Kimberley)	655 feet	Present: 54 ± feet Illinoian: 100 ± feet
Haydenville (11 miles NW of Floodwood)	670 feet (Stout, Ver Steeg, and Lamb, 1943, p.83)	778 feet	705 feet	680 feet	Present: 10 feet Illinoian: 108 feet
Logan (5.5 miles NW of Haydenville)	645 feet	794 feet	741 feet	715 feet	Present: 70 feet Illinoian: 149 feet
Enterprise (4.5 miles NW of Logan, in fill between Hocking and Clear Fork valleys. Bedrock is floor of tributary to pre-Illinoian main stream, near mouth of tributary.)	698 feet	834 feet	(well located outside of Wisconsin Valley)	(well located outside of Wisconsin valley)	136 feet (Illinoian and Present
Rockbridge (2.5 miles NW of Enterprise, in mouth of Buck Run valley)	625 feet	904 feet	742 feet	740 feet	Present: 115 feet Illinoian: 279 feet
Sugar Grove, Fairfield County (4 miles NW of Rockbridge)	640 feet (Stout, Ver Steeg, and Lamb, 1943, p.83)	No data available	No data available	760 feet	Present: 120 feet
Lancaster, Fairfield County (8 miles NW of Sugar Grove)	600 feet (Stout, Ver Steeg, and Lamb, 1943, p.83)	No data available	No data available	810 feet	Present: 210 feet
Canal Winchester, Franklin County (14 miles NW of Lancaster)	550 feet (Stout, Ver Steeg, and Lamb, 1943, p.83)	No data available	No data available	750 feet Elevation of glacial drift surface in old Newark River Valley, to which Logan-Lancaster (pre-Illinoian River) was tributary	Present: 200 feet

ILLINOIAN STAGE

Advance of the Illinoian ice sheet (fig. 2) ponded the Deep Stage drainage system, but the exact position occupied by the ice front at its maximum extent in the Hocking Valley is not known. Leverett (1902, p. 260, and plate 2), and White (1939, p. 166) placed the limit of Illinoian drift a short distance southeast of Lancaster, and Stout and Lamb (1938, p. 75) placed it at Sugar Grove in Fairfield County. At a few points near Rockbridge (fig. 2), the writer found pebbles of glacial origin very high on hills adjacent to the Hocking Valley. In a field on the ridge west of Rockbridge in EC sec. 22, Good Hope Twp., pebbles were found up to 1,000 feet. Auger borings showed that these pebbles are not included in the mantle, which is apparently residual, but are present only on the surface. Whether these pebbles were water-laid and are the remnants of very high terrace deposits or whether they were ice-laid is not known because they were not traced away from this locality. Their presence on the surface and absence in the mantle at locations well above any discernible terrace system suggest that they were ice-laid and that


TERRACE AND BEDROCK ELEVATIONS
HOCKING RIVER VALLEY
ILLINOIAN
WISCONSIN
FAIRFIELD COUNTY
HOCKING COUNTY
ATHENS COUNTY
ELEVATION IN FEET
DISTANCE IN RIVER MILES

the ice advanced down the valley at least to Rockbridge, but further field work is necessary before a definite conclusion can be reached. The Illinoian boundary as mapped by White and the boundary position suggested by evidence outlined in this paper are shown in figure 2.

During the time that the ice stood across the area, the Hocking Valley served as a drainageway for melt waters and a great quantity of gravel was deposited in it. A comparison of the elevations of the bedrock floor and the elevations on Illinoian terrace surfaces (table 2; fig. 5) indicates the fill to have been well over 200 feet near Rockbridge, 150 feet near Logan, and 100 feet near Haydenville. Thickness of the fill for other points is also given in table 2. All of these are minimum thicknesses because (1) there is no assurance that elevations on the bedrock floor were taken in the deepest part of the valley and (2) most terrace elevations are those of preserved terraces. Figure 5 shows other higher terraces projected into areas where wells were drilled which were not used in computing thickness of fill.

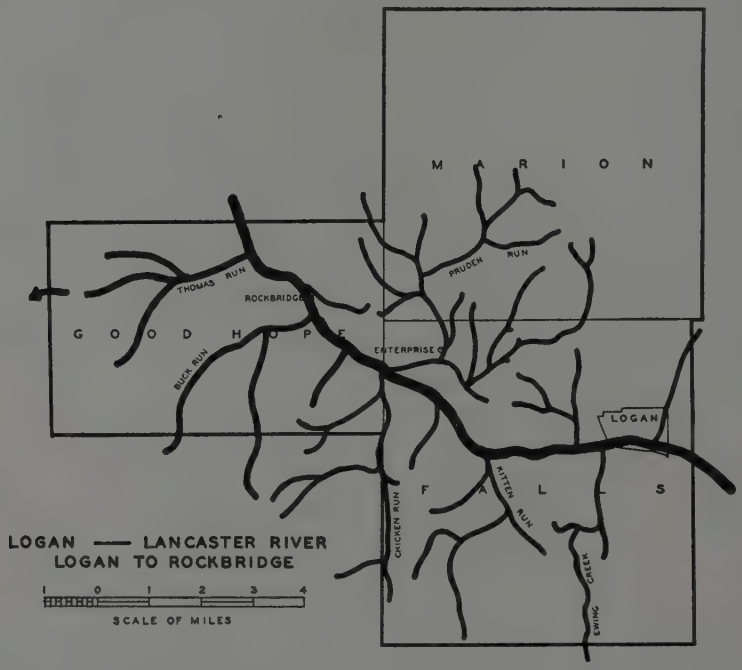
The only way by which these terraces can be dated positively is to trace them upstream into the glaciated area in Fairfield County to determine their relationships to Illinoian and Wisconsin till deposits. This has not been done by the writer, but Leverett, who also concluded they were of Illinoian age (1902, pp. 288–289), may have done so. Bases for the writer's conclusion that they are Illinoian are the depth to which the gravel in them has been weathered and their elevation above lower, much less weathered, gravel terraces interpreted to be Wisconsin (fig. 5). According to R. P. Goldthwait (personal communication), the depth of weathering in the gravel of these terraces compares favorably with the depth of weathering of similar gravel of known Illinoian age near Chillicothe, Ohio, and elsewhere. A representative section of the Hocking Valley gravels measured in a cut on U. S. 33 in the SW¼ NW¼ sec. 25, Good Hope Township, is presented below. Total depth of well-weathered and leached gravel (base of unit 2) is 15½ feet. The base of the oxidized, unleached zone is not exposed. This is the "Hocking soil profile" of pedologists.

	Description	Ft.	In.
Top of Section			
4.	Silt and clay, gray with some brown stain, containing scattered siliceous pebbles; includes surficial soil.....	5	6
3.	Silt and clay, yellow brown; some gray streaks and blobs; many siliceous pebbles; some well-weathered pebbles of other, less resistant, rock types near base..	2	6
2.	Gravel, red-brown to brownish-red; many "rotten" pebbles of crystalline and sedimentary rock types; many siliceous pebbles.....	7	6
1.	Gravel, gray with slight brown stain; calcareous; a few well-rotted pebbles, exposed.....	15	0

Terraces of Illinonian age (fig. 5) occur in the Hocking Valley in Hocking County from the mouth of Clear Creek in Good Hope Township southeast as far as Haydenville in Green Township. They are found in areas protected from post-Illinoian erosion near the mouths of tributary valleys to the Hocking; capping bedrock terraces in the Valley; capping low divides near the Hocking; and filling the abandoned valley segment between Logan and Rockbridge (fig. 3). They are also present high on the hills in the divide between this abandoned portion of the valley and the gorge which the Hocking now follows between Rockbridge and Logan. In addition, they are present in the gorge between Rockbridge and Logan, including the very narrow portion of the valley that crosses an old pre-diversion divide between Rockbridge and Enterprise. The terrace north of Haydenville is the southeastern-most occurrence of Illinoian gravel found by the writer in Hocking County. It is located just northwest of the entrance to the gorge that marks the position of the old divide in which the pre-Illinoian river

or rivers headed. Gravel deposited in this gorge by Illinoian melt-waters has been entirely removed by post-Illinoian streams.

The slope of the Illinoian terraces to the southeast (fig. 5) demonstrates that reversal of the direction of flow of water through the Hocking Valley across the Haydenville divide took place at a time not later than late Illinoian, a conclusion reached by earlier writers (Stout, et al., 1938, p. 76; 1943, pp. 29, 87). The fact that the low divides near Webb Summit, Gore, Greenland School, and at the head of Threemile Creek were sufficiently high to prevent diversion of the Illinoian river into Monday Creek shows that the col southeast of Haydenville must have been at an elevation lower than 760–780 feet. However, Stout and his co-workers, on the basis of bedrock floor elevations, concluded that the Deep Stage Lancaster



River flowed northwest and that the reversal must have taken place during Illinoian glaciation. Much more detailed information about the bedrock valley is needed before the existence and direction of flow of a Lancaster River can be established.

Stout and Lamb (1938, p. 81) and Stout, Ver Steeg, and Lamb (1943, p. 97) state that the diversion of the stream from the old valley between Rockbridge and Logan, now occupied by Clear Fork and a tributary to Buck Run, into the gorge followed by the present river was a result of Wisconsin glaciation. The presence of pre-Wisconsin gravel in the gorge, and particularly that portion of the gorge between Rockbridge and Enterprise, establishes the fact that the diversion occurred at a date at least as early as late Illinoian. Figures 6 and 7 are sketch

maps of the Logan-Rockbridge area on which the present drainage (fig. 7) and the writer's interpretation of the pre-diversion drainage (fig. 6) are shown.

Diversion of the stream could have resulted from damming of the old valley by an ice block extending southeast of Rockbridge and channelling of the melt-waters through the system of tributaries (fig. 6) which antedated the present gorge. Steepness of the higher Illinoian terrace slopes in western Hocking County (fig. 5) suggests that the ice was very near to this area during the period that the gravel in these terraces was being deposited. This, coupled with the probability that glacial pebbles found on the hills above Rockbridge were ice-laid, makes it likely than an ice block may have been a contributing factor in diverting the Hocking River from the old valley to its present course. However, ice-contact

deposits in the abandoned portion of the valley, such as pitted valley train, kame terraces, etc., or ice-laid till are not present to support this interpretation. It is possible that such evidence is, or was, present but has been buried or destroyed by Illinoian outwash or erosion.

Terrace gravels are found as high as 925 feet on the hills in the divide between the existing and abandoned valleys southeast of Rockbridge. This elevation is well above the probable elevations of cols between the tributaries which formerly occupied the site of the gorge (fig. 6). Some of the low points on the divide between the old and new valleys are now underlain by Illinoian gravel covering former bedrock cols; several of the bedrock hills in this divide are completely surrounded by gravel. These relationships strongly indicate that the change

in the course of the river was largely a result of aggradation of the main valley floor to the levels of cols between tributaries north of the valley (fig. 6), with or without an accompanying ice block. This process of aggradation created a wide gravel plain with only a few bedrock hills projecting above it. The courses of the braided meltwater streams flowing over this plain shifted almost at random. When the supply of glacial meltwater and debris was reduced to the point that erosion became dominant over deposition, it happened that the main channel was located over the site of the present valley. Deepening of this channel established the present course of the stream, and the bedrock gorge between Rockbridge and Logan was eroded after the gravel was stripped to expose the cols in the old divides.

The fact that pre-Wisconsin gravel is present in the gorge proves conclusively that the diversion took place at least as early as late Illinoian. Illinoian gravel in the abandoned valley shows that the old course was also effective during Illinoian glaciation. If the interpretation that a Deep Stage Lancaster River flowed northwest is correct, then the Illinoian date of the diversion is established. However, if data obtained in the future on the bedrock valley floor should show that the Lancaster flowed southeast, the possibility would remain that the diversion is of pre-Illinoian age. Cutting of the Rockbridge-Logan gorge could not have been accomplished prior to the reversal of the main stream. It could, however, have taken place at any time later when there was a supply of gravel sufficient to aggrade the valley floors to the required level or when the main valley was blocked in such a way as to channel meltwaters through the tributary system east of Rockbridge.

HAYDENVILLE RIVER (SANGAMON STAGE)

The master stream of the Hocking Valley during the Sangamon interglacial stage was the Haydenville River (Stout, et al., 1943, p. 87). The stream headed somewhere in the Illinoian drift to the northwest in Fairfield County and flowed southeast, following the course of the Hocking past Rockbridge and Logan rather than the valley cut by earlier streams.

If the interpretation is correct that the direction of flow of water through the Valley was to the northwest until Illinoian glaciation reversed it, then it was late Illinoian outwash streams and the Haydenville River that eroded the bedrock gorge through the old divide southeast of Haydenville in Starr Township. The youthful outline of this gorge and the lack of Illinoian terraces from Haydenville to the southeast through the gorge support this interpretation.

Most of the cutting must have taken place after the Haydenville River cut its valley into the Illinoian outwash and exposed the bedrock in the old divide. The rate at which the Haydenville gorge was cut determined the rate at which the river cut its valley into the Illinoian valley train above Haydenville and eroded the bedrock gorge between Rockbridge and Logan. By the time the Wisconsin ice advanced, the Haydenville Valley floor was at least 160 feet below the initial Illinoian surface near Enterprise and at least 100 feet near Haydenville (table 2). These figures represent the difference in elevation between the highest Illinoian terraces and present river level in those areas. The river is flowing on glacial drift at both localities.

WISCONSIN STAGE

The only visible effects of Wisconsin glaciation found in the Hocking Valley in Hocking County are the low gravel terraces which mark the level to which Wisconsin outwash was deposited (fig. 5). For purposes of comparison with that given for Illinoian gravel deposits, a section is presented taken from a small gravel pit in a Wisconsin terrace on the west side of the Valley just south of Enterprise and north of the bridge on U. S. 33. This shows the "Fox soil profile" of pedologists.

	Description	Ft.	In.
Top of Section			
5.	Silt and gravel, dark gray-brown, sharp contact at base; includes surficial soil	0	11
4.	Silt and gravel, yellow-brown; grades to unit below	1	1
3.	Gravel and silt, brown with reddish zones; clayey; pebbles weathered	0	11
2.	Sand, yellow-brown to red brown, darkest color at top; irregular contact with unit below	0	11
1.	Gravel, brownish-gray, calcareous, base not seen	Not measured	

Wisconsin terrace deposits are found all the way down the Valley in Hocking County from the general vicinity of the Hocking-Fairfield County line southeast through the Rockbridge-Logan gorge to the Hocking-Athens County line. The exact depth to which the Haydenville River excavated its valley in Illinoian gravel is not known, and therefore the thickness of Wisconsin fill cannot be determined.

TABLE 3

Drainage chronology of the Hocking River Valley in Hocking County, Ohio. (*Cf. Table 1.*)

DRAINAGE STAGE	AGE	HOCKING VALLEY STREAM		RESULTS	EVIDENCE IN HOCKING DRAINAGE SYSTEM	DIRECTION OF FLOW	LOCATION OF HEADWATERS
Post-Wisconsin	Recent	Hocking River		Incision of valley into Wisconsin valley train	Present drainage system	SE	In glacial drift NW of Lancaster, Ohio
Wisconsin	Wisconsin	Glacial drainage		Deposition of Wisconsin valley train	Terraces of Wisconsin gravel bordering present stream	SE	In glacier near Lancaster, Ohio
Post-Illinoian	Sangamon	Haydenville River		Incision of valley into Illinoian valley train; Probable time of most of cutting of Rockbridge-Logan and Haydenville-Nelsonville gorges.	Pre-Wisconsin valley bordered by Illinoian terrace remnants; relative youth of gorges	SE	In glacial drift NW of Lancaster, Ohio
Illinoian	Illinoian	Glacial drainage		Deposition of Illinoian valley train; latest possible date for reversal of direction of flow of water through valley; latest possible date for diversion from old to present valley between Rockbridge and Logan; initial cutting of Rockbridge-Logan and Haydenville-Nelsonville gorges.	Terraces of Illinoian gravel bordering bedrock valley walls; terraces slope SE; Illinoian gravel deposits in old and present valleys.	SE	In glacier near Lancaster, Ohio
Deep Stage (?)	Yarmouth Interglacial (?)	Lancaster River (?)	A single pre-Illinoian erosion cycle	There is no evidence for two pre-Illinoian (Teays and Deep Stage) erosion cycles in the Hocking Valley. If two cycles did occur, the evidence for the earlier (Teays) was destroyed by Deep Stage and subsequent episodes. It is possible that there was no significant halt in erosion in the Hocking Valley between the Teays and Deep Stage cycles recorded elsewhere in Ohio. The original stream in the valley flowed northwest. Evidence for the course and direction of flow includes abandoned valley segments; gorges; barbed tributaries; northwestward-widening of the Valley from the gorge in the old divide in SW Starr Tp.; and scattered elevations on the buried bedrock valley floor. Relationships between Illinoian deposits and low divides show that Monday Creek and associated streams must have developed, probably through stream piracies, during this time.		NW	In divide in NE Starr Tp., Hocking County.
Pre-Illinoian glacial stage (?)	Kansan(?)	"Finger" lakes (?)					
Teays Stage (?)	Pliocene (?) early Pleistocene	Logan River (?)					

HOCKING RIVER (RECENT STAGE)

Since the retreat of the Wisconsin ice sheet, the Hocking River has excavated a valley about 20 feet deep in the Wisconsin valley train. Deepening of the valley above Logan has been somewhat slowed by the existence of a bedrock waterfall in the channel just west of the city, where a part of the old valley wall has been stripped of its gravel cover.

SUMMARY AND CONCLUSIONS

Table 3 is a summary of the history of the Hocking Valley as it was outlined by Stout and Lamb (1938) and Stout, Ver Steeg, and Lamb (1943) modified by the evidence and interpretations described by the writer.

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Time was when the choice of an elementary text in geology was restricted to three or four old stand-bys. The post-war years have brought forth a number of new ones with a variety of treatment and approach. Of these, that of von Engeln and Caster meets the need for a text covering both physical and historical geology. It is designed both for students taking geology as an elective and those intending to major in the subject.

To attain their goal of logical succession of topics, the authors have developed an unusual plan. Nothing is relegated to appendices, where topics usually considered unimportant or having no logical position in the text are sometimes placed. The plan is admirably suited to attain the "narrative continuity in chapter and topic succession" which the authors have set themselves. The book begins with the materials of the earth, a subject which can be grasped by the veriest beginner. Next, early geologic ideas are examined—appropriately, since most of them are so close to those of the layman—and the ideas of Hutton, Lyell, Agassiz, and others are exposed with the flavor of newness and hot debate which accompanied their first presentation. It is only a step to a consideration of igneous rocks, from their origin to their weathering. In turn, this topic introduces that of sedimentation, the first in the section "Structure, Process, Forms" ending with "Land Forms due to Glaciation." It is here that the authors break with tradition to achieve consistency in sequence of topics. Consideration of glaciation and land forms naturally calls for discussion of the Quaternary history of the earth, in spite of the fact that this is the most recent chapter in that history. Most books on historical geology follow chronological order and "begin with the beginning" in spite of the fact that many principles of historical geology are based on evidence discussed later in the text. The authors have sacrificed chronological order to logical presentation and take the student *backward* into time; the result is pedagogically sound, for the transition from glaciation to Quaternary history is natural. The evidence on length of geologic time, evolution of life, the interior of the earth, and its origin are presented logically, and the principles discussed in the final chapters become much clearer. Guided by a skillful teacher—and both authors have a reputation for dynamic teaching—the student rises from discovery to discovery, each more far-reaching than the last, and his interest is sustained throughout.

Other devices which will recommend the book to teacher and student alike are the lists of questions and references, both of them well selected. The paleogeographic maps are well drawn and accurate, the drawings clear and simple. The taste of the authors is evident in the choice of photographs. For example, they illustrate volcanic tuff not with a formless chunk of rock but with a Toltec idol carved of that material, porphyry with a finely chiseled Roman head, Jurassic limestone by a striking view of the Rock of Gibraltar, and the chalk cliffs of England with a charming photograph of a quiet cove on Lyme Bay. These are incomparably better than the pedestrian illustrations which usually adorn geologic texts.

To sum up, this is an extremely interesting and usable text for beginning geology and one which will meet a wide range of curricular requirements.

AURELE LA ROCQUE.

A COMPARATIVE LIMNOLOGICAL STUDY OF TWO NORTHERN COLORADO MONTANE LAKES

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A comparative limnological study of two northern Colorado lakes was begun during the summer of 1951. The investigation was undertaken in an attempt to determine the relative productivity of the two lakes and to ascertain what factors were contributing to it.

These lakes are located in the northwestern part of Larimer County at an elevation of about 8200 feet and are in the region known as the Red Feather Lakes area. These two lakes, Parvin and Creedmore, were selected for the study because their sources of water are different, although they lie within the same geological formation. Parvin Lake is about 60 surface acres in extent and is fed by a brook, whereas Creedmore Lake contains 14.2 surface acres and receives its water supply from run-off and from seepages on the bottom of its basin. The latter lake has neither inlet nor outlet.

METHODS AND PROCEDURES

All physical, chemical, and biological samples were taken once each week. Temperatures were taken by means of the Foxboro resistance thermometer. Limit of visibility was measured with the Secchi disk.

Chemical analyses for phosphorus, calcium, magnesium, ammonia, nitrogen, and chlorides were done in the laboratory. Dissolved oxygen and hydrogen ion concentration determinations, however, were made in the field.

Biological sampling consisted of quantitative and qualitative determinations of bottom organisms and plankton. Bottom sampling was done by using the Ekman dredge. Plankton collection was accomplished by using the Wisconsin plankton net in conjunction with the Kemmerer-Juday water sampling bottle.

PARVIN LAKE

Physical Factors

Physiography and general description. Parvin Lake was impounded in 1927 by the Colorado Game and Fish Department. The lake is elongate and is classified as a single basin lake. There are several slight depressions within the main basin but none of these was large enough to show any individuality as described by Welch (1928). The shore line is, for the most part, gently sloping, and undoubtedly this factor contributes to the high productivity of the lake. Coves, bays, and numerous smaller indentations are prevalent along the western and northwestern shores. The depth of the lake is variable. The western inlet end is the shallowest portion, whereas, as would be expected, the deepest portion (30–34 feet) is about 50 yards from the dyke on the northeastern shore.

The bottom type is predominantly muck, but the bottom material in the deep portion of the basin is pulpy-peat. The heaviest deposit of muck is in the area of the inlet. This is apparently an accumulation of the sedimentary load from the stream. The volume of flow of the inlet stream varied between 5 and 30 second feet (exclusive of initial spring run-off and floods). Therefore, there was sufficient current to carry the suspended load of the stream for a considerable distance into the lake before deposition occurred. No attempt was made to determine

[1]The author wishes to thank the Division of Fish Research, of the Colorado Department of Game and Fish, for making this study possible.

the rate or amount of muck deposit but it is believed that considerable material has been brought in since the lake was impounded.

Water temperature. The pattern of temperature fluctuation can be seen in figure 1. Thermal stratification occurred about August 7. Although the thermocline that appeared in Parvin Lake was a typical stratification, it was only 5 feet thick and lasted only 10 days. Its disappearance was attributed to a series of high winds that apparently brought about the mixing of the column of water. The effect of the thermocline formation seemed to be reflected in the catch of trout, that is, as the layering of the water became complete, the catch of fish

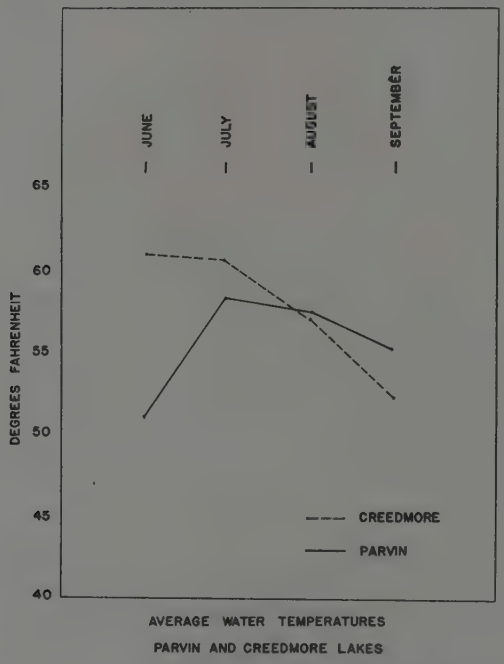

FIGURE 1. Average water temperatures Parvin and Creedmore Lakes.

increased. This was probably due to the fact that oxygen depletion in the hypolimnion had forced the fish into the epilimnion where most of their feeding was accomplished.

Water transparency. Secchi disk readings showed considerable fluctuation in transparency of the water. It is difficult to interpret the effect of these changes upon the organisms within the environment. Usually an increase in water temperature accompanied a decrease in water transparency. In this instance, therefore, it is impossible to determine whether plankters, for example, changed their level of concentration because of temperature factors or light factors. During periods of heavy algal "blooms" the Secchi disk reading was reduced to only 18 inches. The maximum reading at the same sampling station was 10 feet.

Chemical Factors

As has been suggested, Parvin Lake is highly productive. Undoubtedly this productivity is the result of a complex that is related to the basic chemical

constituents within this lake plus the replacement of various elements by run-off and agricultural drainage. The total dissolved solids in the water varied between 60 and 123 ppm. Apparently the variation is due largely to the fluctuation in phytoplankton populations. The inorganic materials, however, remained relatively static throughout the season. For example, chlorides fluctuated only 2 ppm; sulphates, 4 ppm; magnesium, 3 ppm; calcium, 2.8 ppm. Ammonia nitrogen and phosphorus showed more relative fluctuation because the stability of these elements is not as great as those mentioned above. Ammonia nitrogen is influenced by the pH of the water, that is, as the lake water swings from acidic to basic, much of the ammonia is volatilized. Moreover, phosphorus fluctuation is apparently due to its changes in combination with other elements within the lake and between the bodies of plants and animals within the environment. It has also been shown that there is some exchange of phosphorus between water and bottom mud. Therefore, the recorded amounts of this element could be much in error, contingent upon the position of the phosphorus at the time of sampling (Hayes et al., 1950). Since the water of Parvin Lake is constantly being replaced, it would seem that the amount of available phosphorus is certainly adequate for the support of plants and animals.

Hydrogen ion concentration. Like some other chemical phases of limnology, hydrogen ion concentration is not well understood as it relates to the animals and plants of a particular lake. An increase in the pH of Parvin Lake occurred during the middle of the summer. This change in pH began about the last week in August. It was noted that this increase closely paralleled the decrease in volume of flow of the feeder stream. It is therefore suggested that the decreased flow permitted a greater concentration of hydroxyl ions to be built up in the areas of open water. Since the water was already basic in character, evaporation and stagnation contributed still more toward this alkaline condition.

Oxygen. For the most part, the water maintained a condition of oxygen saturation. The two exceptions to this were: (1) a period when the localized growth of Canada waterweed was at a peak and thereby produced enough oxygen to bring supersaturation of that area; (2) the condition of oxygen depletion that existed in the hypolimnion during the period of thermal stratification. At no time was there any evidence of oxygen depletion affecting the larger aquatic organisms other than to cause their migration to the oxygenated thermocline or epilimnion. This was particularly noticeable in the case of fish. The number of fish caught by angling increased perceptibly during the above-mentioned period.

As a final point concerning the productivity and chemically related factors in Parvin Lake, it is suggested that the recent formation of the lake has influenced its richness. Since the basin of this lake was once agricultural land (grazing), it may be assumed that a considerable amount of organic and inorganic material was inundated. Plant and animal remains within the lake have added to these materials. Undoubtedly the original inorganic material in the substrate is still in the process of leaching and is contributing to the fertility of the lake.

Biological Factors

Vegetation. The dominant submerged vegetation in Parvin Lake is Canada waterweed, *Elodea canadensis*. Its position in the lake is somewhat confined to the shallow western end and to the protected coves. Its maximum growth has been attained by about August 1 and had become so dense in the inlet that fishermen were unable to fish in that area. It was at this time that dissolved oxygen content and temperature reached maxima. This would seem paradoxical were it not known that *E. canadensis* is one of the highest producers of oxygen (Schaeperclaus, 1933). On days of bright sunlight, bubbles of oxygen could be seen rising from the beds of submerged waterweed.

In coves on the northwestern side of the lake there were considerable areas

of pondweed, *Potamogeton richardsoni*. Since this plant is less dense in its growth, it is believed that these areas offer excellent foraging grounds for trout. It was observed that schools of minnows and many aquatic insects frequented these beds of pondweed.

The main function of the higher aquatic plants in Parvin Lake would seem to be that of breeding grounds for aquatic invertebrates. Undoubtedly, these plants also serve as protection for smaller fish, and resting, feeding, and hiding areas for the larger fish. Their contribution to the oxygen level of the lake as a whole is apparently of slight significance since the flow and wave action of the water tend to maintain a condition of oxygen saturation. The role of the larger aquatic plants in the chemical balance of the lake would lie in their contribution to the dissolved phosphorus and nitrate in the water.

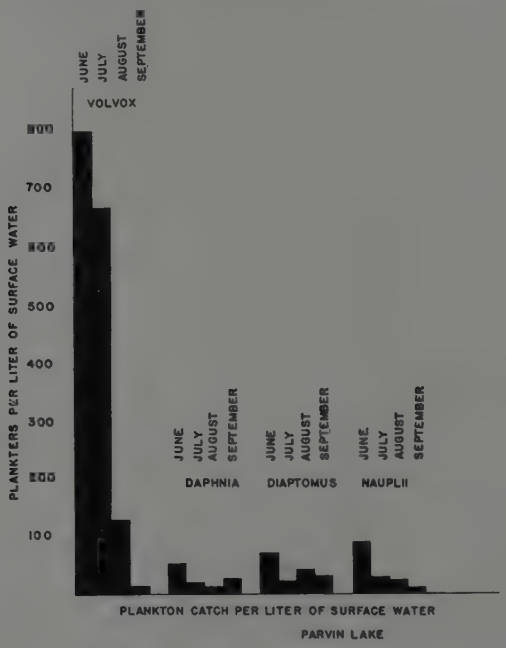

FIGURE 2. Plankton catch per liter of surface water. Parvin Lake.

Plankton. A quantitative evaluation was made of four plankters. These were: *Daphnia longispina*, *Diaptomus coloradensis*, *Volvox globator*, and the nauplii of Diaptomus. Of these plankters, *Volvox* was the most easily observed since it contains chlorophyll and is relatively large. At times of peak populations of *Volvox* (fig. 2) the water had a definite greenish appearance. The increased population of *Volvox* caused a decrease in the penetration of light into the deeper portions of the lake and, in turn, apparently affected the position of the other plankters in the area. For example, *Diaptomus*, which was usually found at depths of 15–20 feet, was found at depths of 3–8 feet when large numbers of *Volvox* appeared in the surface water. How changes in stratification of plankton affected the feeding of fishes in Parvin Lake is not known (fig. 4).

Since plankton is often used as an index of lake productivity, it would seem that such an index could be applied in the case of Parvin Lake. It is probable

that the excellent fish growth that has been recorded for this lake (Klein, 1950) might be traced directly or indirectly to the relatively large crop of plankton which is produced.

Bottom organisms. The diversity of bottom organisms in Parvin Lake was not great, although the number of organisms per square foot was often high.

The most abundant organisms where midge larvae, *Chironomus* spp. There were about 5 species of chinonomids, but no attempt was made to identify them. It was noted that their periods of emergence were scattered throughout the entire summer. This factor is thought to be of importance since both midge larvae and adults are utilized as trout food.

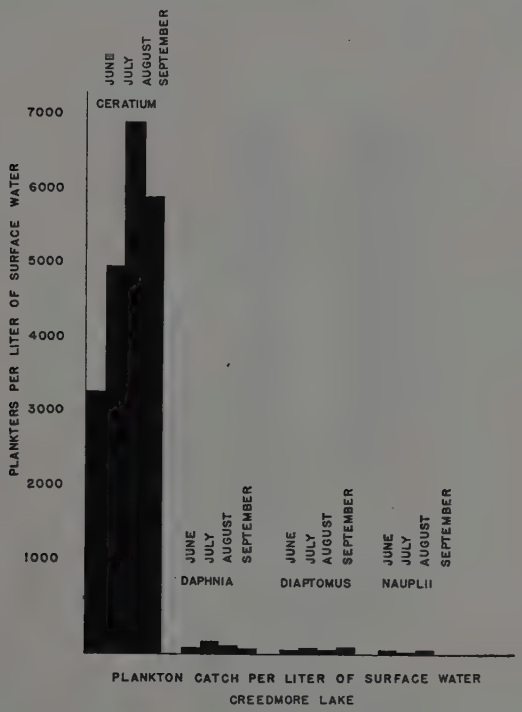

FIGURE 3. Plankton catch per liter of surface water. Creedmore Lake.

Aquatic earthworms were second in abundance among the bottom animals. There was considerable fluctuation in the earthworm population as it was sampled, however. Apparent variations in their numbers can probably be attributed to their vertical migrations within the organic ooze on the bottom of the lake basin. Therefore, when the worms were deep in the bottom mud, they were beyond reach of the Ekman dredge.

Undoubtedly the annelids in Parvin Lake were utilized to some extent by fishes, but their significance as a food item is probably slight. The main contribution of aquatic earthworms is their ability to bring about mixing of the bottom material and to aid in the breakdown of detritus. By this means they contribute to the food of the more numerous midge larvae, which are detritus and ooze feeders.

CREEDMORE LAKE

Physical Factors

Physiography. Like Parvin Lake, Creedmore has a single basin. Since its surface area is only 14.2 acres, there is little variation in the bottom contour. The basin is bowl-shaped with a regular shore line. The eastern, southern, and western portions of the littoral zone are gently sloping. In contrast, the northern shore line dips abruptly toward the deepest portion of the basin which is about 25 feet from that shore. It is estimated that during spring run-off the greatest depth of the lake was about 11 feet. During the course of the investigation the depth at the sampling station, which was considered the deepest spot in the basin, did not exceed 10 feet. By the first of October the depth at the sampling station had decreased to about 8.5 feet.

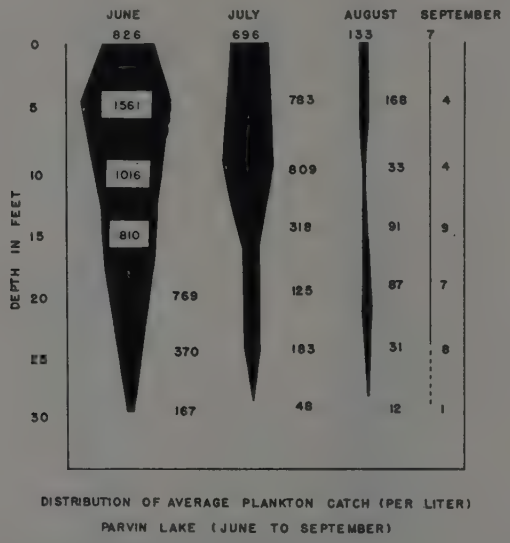

FIGURE 4. Distribution of average plankton catch (per liter). Parvin Lake (June to September).

The bottom type in Creedmore is essentially homogeneous. The predominant mass of bottom material consisted of muck interspersed with fragments of plants. The only departure from this bottom type was found on the eastern shore where a small zone has a bottom type of sand and fine gravel. Since this is the wind-swept shore, it may be assumed that the molar action of waves has brought about the condition of a sandy beach. It is doubtful that this beach area ever will support rooted vegetation due to the constantly shifting nature of the substrate. It must, therefore, be considered very low in productivity as compared to the rest of the lake area.

Water temperature. Since Creedmore is a shallow lake, the water temperatures were relatively uniform throughout the summer (fig. 1). The homothermos conditions and the absence of thermal stratification are related to the shallowness of the lake and the great amount of wave action across its surface. At times of high wind, there was considerable turbidity which indicated that the water was in complete circulation. The amplitude of wave action may be visualized

when one considers that winds up to 80 mph were acting upon the lake's surface. On several occasions winds were of such violence that considerable quantities of water were whipped from wave crests and then dropped 10–12 yards from the lake. It is doubtful, however, that the quantity of water lost in this manner was of any significance. At any rate, it must be concluded that thermal stratification was impossible under such circumstances.

Water transparency and color. The Secchi disk readings on Creedmore Lake correspond to the depth at the sampling station (8.5–10 feet). In other words, transparency of the water was such that the lake bottom could be observed without difficulty. Therefore, the disk readings are not included in this study.

The true color of the water was clear. There was no variation from this during the season. Apparent color was light green. This color was attributed to the presence of phytoplankton and the refraction of light from the emergent and submergent vegetation.

Chemical Factors

As previously stated, Creedmore Lake has neither an inlet nor an outlet; therefore, concentration of various chemical constituents have been built up over a long period of time. This seems to be the result of the leaching of the substrate and, to a lesser extent, the leaching of the surrounding rocks. Total solids were considerably higher in this lake than in Parvin Lake. Volumetrically they were determined to fluctuate between 175 and 320 ppm. Again as in Parvin Lake, the fluctuation was largely due to changes in suspended organic matter, detritus, and plankton. As the water level decreased toward the latter part of the summer, the concentration of calcium, chlorides, and magnesium increased perceptibly. It appears that this increase resulted primarily from water evaporation.

The phosphorus content of Creedmore Lake was somewhat less than that of Parvin Lake. In attempting to account for this smaller quantity of phosphorus, it is suggested that there has been actual removal of this element. That is, phosphorus contained in the bodies of fish is removed from circulation when the fish are taken from the lake. Since there is no feeder stream in Creedmore, the above mentioned phosphorus is not being replaced from the drainage basin.

Ammonia nitrogen was present at the rate of about .06 ppm. This minute quantity was probably related to the pH of the water (7.7 to 8.8). Under this condition of alkalinity, the ammonia, for the most part, was volatilized as soon as it was manufactured. This condition is no doubt fortunate, inasmuch as the large amount of organic material on the lake bottom could conceivably produce toxic quantities of ammonia during the season of ice-cover.

Biological Factors

Vegetation. Probably the dominant vegetation in Creedmore Lake is pondweed, *Potamogeton* spp. Only a small portion of the littoral zone and the deep portion of the lake was devoid of this plant. The growth of *Potamogeton* was exceedingly heavy in the central portion of the lake and, as a result, discouraged most fishermen from fishing in that area. It may be assumed that large populations of aquatic invertebrates occupied the beds of *Potamogeton*, since "spot" sampling revealed many organisms clinging to the stems and leaves of these plants. Due to the high food factor, it is likely that fish utilized the pondweed region as a feeding and resting ground. Water temperatures were never appreciably higher over the pondweed beds than they were at the sampling station which was located in a weed-free spot near the north shore of the lake. Peak growth of *Potamogeton* was reached about the middle of August. Portions of dead stems and leaves could be found drifting or piled against the windward shore from that time until the first of October.

The second plant of importance in Creedmore Lake was the complex green alga, *Chara* spp. Apparently this plant covered the major portions of the lake

bottom, except for the sandy beach near the wind-swept shore. *Chara* always formed a thick mat of vegetation in those portions of the lake where organic ooze and detritus made up the substrate. Sampling in any of these areas always produced large numbers of amphipods. It was found also that the column of water immediately above the heavy *Chara* beds seemed to support a heavier plankton population than those *Chara*-free areas of the lake. No comparative study was made concerning this phenomenon.

Water smartweed, *Polygonum* spp., was also present in this lake. Its distribution was confined to the shallow, leeward shore. It is believed that the limnological significance of this plant was slight since it was not abundant nor were there many aquatic animals in or near the plants. Since the leaves are sparse and floating, there is little cover afforded by this plant.

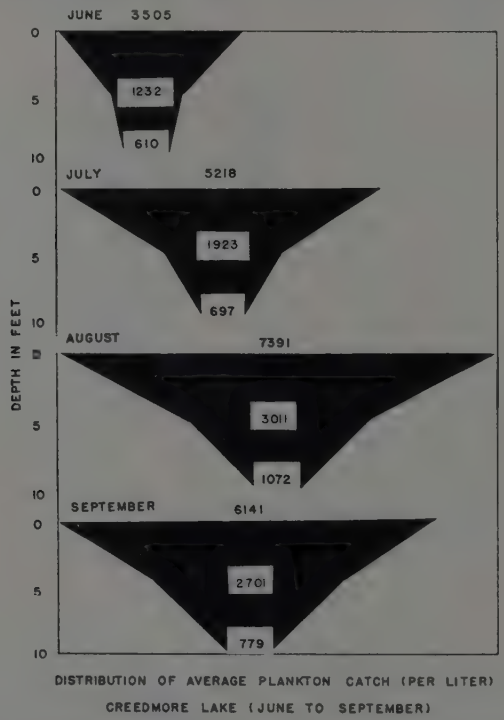

FIGURE 5. Distribution of average plankton catch (per liter). Creedmore Lake (June to September).

Plankton. An attempt was made to select the same genera of plankters for study in Creedmore Lake that were studied in Parvin Lake. This was possible with one exception. Namely, *Ceratium* spp. had to be substituted for *Volvox globator* since the latter was found only occasionally in Creedmore Lake. Thus, the four plankters considered in the Creedmore investigation were: *Daphnia longispina;* the copepod, *Diaptomus coloradensis;* the flagellate, *Ceratium* spp; and the nauplii of *Diaptomus.*

By far the most abundant plankter in Creedmore was *Ceratium.* At times

of good water transparency, there was some difference in its vertical distribution within the water column at the sampling station (fig. 5). A maximum population of 15,277 Ceratium per liter was recorded on August 30. *Ceratium* exhibited greater fluctuations than the other three organisms. *Diaptomus*, *Daphnia* and the nauplii showed similar population patterns in both Parvin and Creedmore Lakes. The over-all plankton population of Creedmore, however, was somewhat lower than that of Parvin. It is probable that the shallow character of Creedmore is directly related to the smaller standing crop of plankton in the lake. Further, there is no true limnetic zone in Creedmore and it is generally agreed that large plankton populations usually require open water of considerable depth. Finally, there is undoubtedly competition for space between higher aquatic plants and the various plankters in Creedmore Lake. In spite of this apparent crowding, there seemed to be adequate plankton to support the forage fish in the in-shore zone. From the few trout stomachs that were examined, there was no evidence that plankton was utilized by these fish in Creedmore Lake.

Bottom organisms. The bottom fauna of Creedmore Lake was monotonous. The major group of organisms was midge larvae, *Chironomus* spp., with aquatic earthworms ranking next in numbers of individuals. In some instances, amphipods, *Gammarus* spp., tended to confuse the picture of the bottom fauna. The latter could not be considered a true bottom organism in this lake since they were associated with the *Chara* plants. Because the plants were above the ooze substrate, it is assumed that they had been knocked from the vegetation by the dredge and subsequently appeared in the bottom samples.

Examination of a limited number of rainbow trout stomachs showed that bottom organisms were utilized to a limited extent in Creedmore Lake. The density of the vegetative mat, formed by *Chara*, may account for this lack of utilization. Moreover, the factor of vertical migration within the substrate, as it operated in Parvin Lake, was undoubtedly applicable in Creedmore Lake.

SUMMARY

Two montain lakes were compared limnologically to determine the interrelationship of the physical, chemical, and biological factors. Further, there was an attempt to determine the relationship of the above mentioned factors to the over-all productivity of these lake waters.

The following findings were believed to be pertinent to this study: (1) The great irregularity of the shore line of Parvin Lake tends to contribute to a greater productivity than that of Creedmore Lake, which has a regular shore line. (2) The constant replacement of important chemical constituents in Parvin Lake, due to a "feeder" stream and outlet, tends to place it in a higher productive bracket than Creedmore, which obtains water from run-off and seepage. Also the youthful condition of Parvin Lake permits the leaching of more inorganic material from its substrate than is true in the case of Creedmore. (3) Plankton exhibited population fluctuations. Bottom organisms showed a somewhat inconsistent pattern of abundance. which might be attributed to vertical migrations within the substrates of the two lakes. (4) The biological productivity of Parvin Lake seems to be higher than that of Creedmore.

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BASIC WATER CONCEPTS FOR SOIL AND WATER CONSERVATION

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Soil erosion—a matter of current national concern—results from untamed wind and water. In this, the humid area of the country, water is the major, and wind the minor, factor in this erosion process. It is the purpose of this paper, therefore, to present for this region some of the important basic principles of water behavior on and in the land as they relate to soil and water conservation. Although certain phases of this presentation are somewhat elementary, they will provide a clearer understanding of the erosion picture and the soil- and water-conservation job ahead.

Let us start with a review of the precipitation pattern for Ohio. The average annual precipitation over the state of 37 to 40 inches of water comes mostly in the form of rain. Of the snowfall, very little is erosive unless it melts rapidly causing runoff on partly thawed bare ground. Rainfall, however, is erosive from the time the drops strike the bare ground until the runoff water reaches its resting place in ponds, lakes or oceans.

The average annual precipitation is quite evenly distributed over the months of the year. Those months averaging less than three inches of precipitation come in the 7-month period, September through February. The other five months, March to August, all have over three inches of rainfall with July having the greatest average value of nearly four inches. Let us now consider seasonal differences in rainfall characteristics, and by listing some of the most important ones (table 1) we can get a clearer picture of rainfall factors causing erosion. For comparison, we will divide the year into two seasons, namely, the growing (5 months, May-September) and the dormant (7 months, October-April).

The U. S. Weather Bureau has for many years classified storms by their intensity, listing those storms having 0.25 inch rainfall in 5 minutes, 0.35 inch rainfall in 15 minutes, 0.50 inch rainfall in 30 minutes, 0.80 inch rainfall in 60 minutes, etc., as "excessive storms." Yarnell (1935) summarized these excessive storms for the country and found that for Ohio about 90 per cent of the excessive storms occurred in the growing season. This concentration of excessive storms of high intensity and large drops with high velocity constitutes a severe erosion hazard. Borst (1945) and others found that of the annual average erosion on a plot of bare soil, about 85 per cent occurred in this 5-month period of high rainfall intensity. A few excessive storms cause the bulk of the annual erosion. It is often possible at such times to provide some protection to the land surface by adjustments in the cropping system—thus reducing erosion.

While the characteristics of normal seasonal rain-storms are fresh in mind, it is well to discuss briefly the hydrology of flood genesis. It is common knowledge that the large river-basin floods occur mostly in the late winter or early spring. They are caused by dormant-season storms of low intensity, small drop size and of low velocity, but covering large areas of wet soil and lasting for several days. Small streams are usually within their banks at this time, yet when all such tributaries contribute their flow simultaneously to the large river, a major flood results. For river basins in this section of the country having drainage areas of 10,000 square miles and larger, over 90 per cent of the greatest annual floods occur in this dormant season. For streams having areas of under 10 square miles, less than 15 per cent of the greatest annual floods are in this season. Over 85 per cent

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occur in the growing season. Harrold (1949) illustrated the magnitude and importance of the small-area flood for the Ohio area and related it to the definite seasonal rainfall characteristics described above.

Now let us return to the consideration of the intimate relationships between rainfall, the land, erosion, and runoff-water loss. It has been well established that the greatest erosion hazard from rainfall on bare soil is in the May-September season. From studies at Experiment Stations of the U. S. Soil Conservation Service and of the various States, it may be concluded that vegetation or any other cover on the soil surface is effective in reducing soil loss. With such complete coverage as provided in ungrazed woodland and grassland, erosion is negligible. As water absorption into the ground of such areas is usually at high rates, runoff losses are low. Although complete vegetal cover is the best for soil and water control, it does not appear economical or practical to completely eliminate from farm land crops which provide little or no soil coverage. It is reasonable, however, to make some change in this direction. Lessening of clean-cultivated acreage on erodable land and the increase of acreage in sod crops or trees is one of the main features of soil and water conservation programs. Studies in Ohio and elsewhere have

TABLE 1

Some important seasonal rain-storm characteristics

Item	Normal seasonal character	
	Growing	Dormant
Intensity	High	Low
Drop size	Large	Small
Drop velocity	High	Small
Duration	Short	Long
Storm area	Small	Large

also found it possible to reduce soil erosion by significant amounts through the proper use of mulches in orchards, row crops, and the like. Although such changes in land treatment are immediately reflected in very noticeable changes in erosion, changes in the rates and amounts of water absorption by the soil are accomplished over a period of years.

Realizing that certain areas in row crops will still be required to meet crop goals, experiments are being made to determine how this can be done on sloping land while keeping soil and water losses to an acceptable minimum. Contour cultivation, terraces, contour strip cropping and the like, have been found to retard the down-hill flow of water and reduce the amount of soil loss. In straight-row farming on 12 per cent land slope where the down-hill flow of water was rapid, the corn-season erosion amounted to about 20 tons of soil per acre. That from contoured cornland totaled only four or five tons. In sloping rows the excess water flowed rapidly thus carrying large quantities of soil. In contour rows, the flow of water was very slow and the amount of soil carried low. There was very little difference in the amount of runoff water from both areas.

On contoured land, provision must be made to transport excess water from the contour furrows down hill to the stream channels. When excess water in the furrows of contoured farmland on sloping ground is released haphazardly, erosion is as serious as in straight-row cornland. Soil erosion is a definite loss in either case. Sod waterways properly designed, constructed, and maintained have been found to handle this down-hill release of water without erosion.

The general concept of erosion has been a big pile of soil weighing many tons. It is more than that. Soil carried off the farm in runoff water includes high concentrations of organic matter, nitrogen, phosphate, potash, and other plant-food elements. Robert Hickok, Soil Conservation Service Research technician in. Indiana, found that these losses were great even on a low slope of only three per cent. In the yearly runoff water from a straight-row cornfield there was found 22 pounds of nitrates, whereas on a contoured cornfield this loss was only five pounds per acre. So we find that erosion is more than just tons, it has a significant dollar value. It is part of an investment.

The foregoing discussion on the benefits of contour farming pertains mainly to sloping land where erosion is significant. For such sloping land, the amount of water held in the furrow depressions is a function of the degree of slope. On rolling and hill land, the effectiveness of contour cultivation on water conservation becomes less as the land slope increases. On the flatter lands, contour furrows retain a considerable amount of water—in fact, too much water at times in some areas of Ohio. The additional water retained on poorly-drained soils by contour cultivation has caused crop-yield reductions. In such areas, it is desirable to speed up the removal of excess surface water by tiling, open ditches, land smoothing (removal of pockets), bedding, and by agronomic practices which improve the

TABLE 2

Infiltration rate for Muskingum silt loam topsoil

Soil moisture content (percentage by volume)	Infiltration rate of 7-inch topsoil (inches of water per hour)
5	9
20	6
40	2
45	1

internal drainage of the soil profile. Benefits will accrue by retention of more water on some land but in other areas it is desirable to remove excess surface water rather quickly. In all cases, however, where water leaves the farmland, its flow should be managed so as to keep erosion to a minimum.

Studies of rainfall, runoff, and infiltration have shown that the ability of a particular soil to absorb rainfall is greatly influenced by the dryness of the soil. If the soil is quite dry, there are many unfilled pores through which water can be transmitted by gravity to lower depths. If the soil is wet, the water-transmission rate will be slow. These factors affect the infiltration rates of most soils, somewhat as they do for the Muskingum silt loam topsoil of the Coshocton Experiment Station (table 2). The permeability of the profile below this topsoil is much less—being about one-twelfth the amount as fet forth in table 2.

A knowledge of these and other hydrologic characteristics of the soil will aid in the interpretation of the soil's part in the disposal of rainfall into runoff, infiltration, percolation and water held in storage. Some of these important qualities are:

1. Saturation. All pores filled with water.

2. Field capacity. Amount of water held in soil after gravity water has drained out. Volume of de-watered pores termed "air space porosity" is indicative of the soil permeability.

3. Wilting point. Water held in soil so securely that plants wilt from lack of water.

For a root-zone of 40 inches of the Muskingum silt loam soil, according to

Dreibelbis (1944), there is about 17 inches of water in the profile at saturation, 13 inches at field capacity and 3 inches remaining at wilting point. Whenever there is on the average more than 13 inches of water in the 40-inch profile, there is some free water that drains to greater depths. In order to help visualize these factors and the part they play in soil-water supplies and movements, they may be illustrated on a graph with the months of the year along the bottom scale and soil-moisture content as the vertical scale. Lines for saturation, field capacity and wilting-point moisture can then be drawn horizontally across the graph at the proper soil-moisture figure on the vertical scale.

On this graph, a curve can be sketched in to show the general trend of soil moisture in the 40-inch profile throughout the year. Usually this curve will approach saturation in the late winter and early spring period. The curve then normally dips down close to the moisture content of wilting point near the end of the summer. As the moisture content of the soil depletes by drainage or by evaporation and transpiration, soil pores are de-watered and a potential water-storage reservoir develops within the root zone. At times in the summer the volume of de-watered pores in the 40-inch profile is large enough to absorb up to 10 inches of rainfall.

For soil and water conservation and other public and private programs, it may be most desirable to have near the soil surface a large potential storage reservoir such as this. As the moisture content of the soil lessens, the volume of the potential storage increases. This situation ceases to be ideal when the soil moisture becomes so low that it is inadequate to meet crop requirements. The possibility of making good use of this storage reservoir during storm periods depends on a number of factors such as soil structure, vegetal cover, and land management. Soils having good internal drainage characteristics and tilled or managed at the surface so as to maintain high infiltration rates, will make use of their storage capacities over and over again. From time to time, rainwater from flash summer storms is absorbed into this soil reservoir. The pores become wholly or partly filled with water to varying depths. Some soil water will drain to lower levels, some will be evaporated from the land surface, and some will be transpired by vegetation. Thus, the soil reservoir is de-watered and ready to absorb water from the next storm.

Variations in the permeability of the soil profile are found in almost all soil types. Those at the Coshocton Experiment Station have a fairly permeable topsoil to a depth of 7 inches as illustrated before. If the land surface is protected and does not pack and seal, the de-watered pores in this topsoil fill rapidly during a storm period. Often the volume of these pores is great enough so that there is no runoff water. Since the subsoil is much less permeable, the de-watered pores therein fill very slowly. The storm is often over before its water penetrates much below the 7-inch depth. Observations indicate that runoff has occurred many times when there was enough volume of de-watered pores within a foot of the land surface to absorb all of the rainwater. This waste ought not to be.

The greatest factor restricting the use of the soil of crop land as a reservoir is surface sealing and packing from raindrop impact. The large raindrops falling at high velocities strike bare soil with great force. This energy is expended in packing the soil and breaking soil crumbs into fine particles. Both actions tend to change a loose, porous soil surface into a dense, tight, nearly impervious layer. It is not uncommon to have large quantities of water and soil lost from cultivated fields during a summer storm although there was within a few inches of the land surface sufficient de-watered pores to absorb all the storm rainwater. On July 28, 1951, for example, only about half of 1.1-inch rainfall was absorbed into a contoured cornfield and half was lost in runoff. Before the storm, the volume of de-watered pores in the 7-inch topsoil totaled 2.8 inches. All of the storm water could have been absorbed, yet half ran off carrying 2 tons of soil from each acre of the field. This is just one example of many. Again, this waste ought not to be.

Studies of the hydrologic characteristics of the soil profile along with a knowledge of the erosion hazard of our rainfall, fluctuations of soil moisture, and efficiency in the use and re-use of de-watered pore-reservoir capacity point to the need for the determination of ways and means of land management for greater water conservation and less soil erosion. Experiments are showing that mulches on bare soils reduce the effect of raindrop impact on surface sealing. Here, the force of many falling raindrops is expended on the mulch material rather than on the soil particles. For the same storm used in the above example, there was no runoff or erosion from the mulched corn watershed. Thus, if the surface seal in bare land can be eliminated or even partly reduced by use of mulches or other means, it may be possible for the de-watered pores at shallow depth to be used more frequently.

Besides the problem of maintaining a porous soil surface, there is a need to determine if it is possible to affect the permeability of various layers in the soil profile for improving their water-handling characteristics. Many soils, like those on the Coshocton Experiment Station, have layers of fairly low permeability at shallow depth which often limits the amount of storm water than can be absorbed. By gradually adding to the depth of plowing which would deepen the placement of organic matter or by other means, it may be possible to increase the depth to which storm water would move rapidly. If so, a volume of de-watered soil pores at greater depths would become more readily available and thus provide further improvement in the water conservation and management job.

Another of the basic water concepts which has influenced some of those previously discussed is that of the crop needs for water. Soil-moisture depletion by a deep-rooted grass, legume, or tree crop is at times more extensive than that of shallow-rooted crops. Moisture depletion rates for some crops are different from others for various months of the long growing season. For example, a corn crop in June has generally been found to de-water soil pores at a much slower rate than a good meadow or pasture.

Water needs for crops is an item of general concern, especially when drought conditions are experienced. In some areas it has been found desirable and economical to provide a means of supplementing rainfall with irrigation water. Because auxiliary water supplies for this purpose are often limited and in some places becoming exhausted, and because the delivery of this water to the plant is rather costly, it is most desirable to supply just enough irrigation water and no more. In other words, eliminate any waste of water. An understanding of the basic soil, water and plant relationships such as saturation, field capacity, infiltration and permeability rates, water demands of crops (evapo-transpiration), and wilting point is most important in this field of agriculture.

As a knowledge of various soil, water, and plant relationships is advanced, there will be available a sounder basis for water management programs of all types and a more complete set of facts for planning the proper land management under a wide variety of field conditions.

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SPECIES, DISTRIBUTION, AND HOST RECORDS OF THE BRACONID GENERA *MICROCTONUS* AND *PERILITUS*

(HYMENOPTERA: BRACONIDAE)

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During the course of an investigation of the biology of *Microctonus vittatae* Mues., the author compiled a list from available literature of the species of the braconid genera *Microctonus* Wesmael and *Perilitus* Nees together with their known distribution and host records. Earlier but less complete lists of similar nature were presented by Speyer (1925), Jackson (1928), and Muesebeck (1936). The additions included below were scattered widely in the world literature. No pretense is made that this listing is complete or without error. This results in part from the fact that specimens were not examined and that confusion has existed in the classification of the braconid subfamily Euphorinae, to which these genera belong.

SYSTEMATIC POSITION OF THE GENERA *Microctonus* AND *Perilitus*

The genus *Microctonus* was erected by Wesmael in 1835 to include those species of *Perilitus* having two cubital cells in the fore wing. The genus was further restricted by Foerster in 1862 to include only those species in which the first cubital areolet is confluent with the first discoidal. Until 1936, most workers in the Braconidae overlooked or disregarded Foerster's type fixation in the case of *Microctonus* with the result that the true members of this genus have been called *Perilitus*. At the same time the true *Perilitus* were placed in the genus *Dinocampus* Foerster. Muesebeck (1936) revised the genera of the Euphorinae, suppressing *Dinocampus* and dismembering the group originally given the name *Perilitus* to the extent that this restricted genus has become more or less obscured.

According to Muesebeck, the division of the two genera on the basis of the separation (*Perilitus*), or confluence (*Microctonus*), of the first cubital and first discoidal cells, "is obviously an artificial one; but since the species arrange themselves so conveniently into two groups by this character, it has been considered advisable to consider both names as valid." Because these genera constitute a natural group, they have been treated together in this paper.

TABLE 1

Recorded parasitism of adult beetles by the genera Microctonus *and* Perilitus.

Parasite	Host	Reference	Distribution
Microctonus			
M. aethiops (Nees)	CURCULIONIDAE		
	Sitona hispidula Fab.	Speyer, 1925	Europe, introduced N.
	S. cylindricollis Fahr.	Munro, 1948	Dak, U.S.A.
	CHRYSOMELIDAE		
	Phyllotreta vittula Redtb.	Kaufman, 1923	
	P. nemorum L. (Larvae of latter)	Newton, 1931	

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TABLE 1—(Continued)

Parasite	Host	Reference	Distribution
M. basalis (Curtis) (*bicolor* Wesm.)	*P. atra* Fab.		Europe
	P. undulata Kutsch.	Kaufmann, 1923	
	P. vittula Redtb.		
	Psylliodes attenuata Koch.	Dmitriev, 1935	
	Longitarsus longipennis Kuts.		Central Russia
	L. pellucidus Foudr.	Zorina, 1939	Crimea
M. brevicollis (Haliday)	*Haltica ampelophaga* Guér. (Larvae and Adults)	Künckel d'Herculais & Langlois, 1891	Algeria
M. carabivorus Muesebeck	CARABIDAE *Galerita* sp.	Muesebeck, 1936	Va. and Ia., U.S.A.
M. cerealium (Haliday)	CURCULIONIDAE *Sitona hispidula* Fab.		
	S. sulcifrons Thrugb.	Jackson, 1924	Europe, England
	S. lepidus Gyllenhal		
M. eleodis (Viereck)	TENEBRIONIDAE *Eleodes opaca* (Say)		
	E. suturalis (Say)		
	E. obsoleta (Say)		
	E. extricata (Say)	McColloch, 1918	W. U.S.A., Kan., & N. Mex. NW to Wash.
	E. tricostata (Say)	Muesebeck, 1936	
	E. hispilabris (Say)		
	E. vandykei Blaisdell		
	Embaphion muricatum Say		
	E. planum Horn		
M. epitricis (Viereck)	CHRYSOMELIDAE *Epitrix hirtipennis* Melsh.	Peterson, 1932	Va. to Ill., U.S.A.
	E. cucumeris (Harr.)	Cameron, 1915	
M. gastrophysae (Ashmead)	*Gastrophysa cyanea* Melsheimer	Muesebeck, 1936	D.C. and Va., U.S.A.
	G. viridula (Degear)		
M. melanopus Ruthe	CURCULIONIDAE *Ceutorrhynchus quadridens* Panz.	Speyer, 1925	Germany
M. mellinus (Provancher)	Not known	Muesebeck, 1936	E. seaboard Amer., Quebec to Ga.
M. morimi Ferriére	CERAMBYCIDAE *Morimus asper* Sulzer	Grandi, 1931	
		Goidanich, 1933	Italy
M. nigritus (Provancher)	Not known	Muesebeck, 1936	Quebec & Mich., Amer.
M. parcicornis Ruthe	Not known	Lyle, 1933, Kloet & Hincks, 1945	Britain
M. pusillae Muesebeck	CHRYSOMELIDAE *Phyllotreta pusilla* Horn	Muesebeck, 1936	Gt. Plains Sts., W. U.S.A. and Canada
		Chittenden & Marsh, 1920	
	P. albionica Lec. (?)	Glendenning, 1927	

TABLE 1—(Continued)

Parasite	Host	Reference	Distribution
M. spurius Ruthe	Not known	Lyle, 1933, Kloet & Hincks, 1945	Britain
M. vittatae Muesebeck	*Phyllotreta striolata* (Fab.)	Chittenden, 1920	E. coast Amer. west to Gt. Plains Sts.—Ont. to La., Japan (?)
	P. bipustulata (Fab.)	Peterson, 1932	
	P. zimmermanni (Crotch)	Smith, 1949	
Microctonus sp.	CURCULIONIDAE		
	Cylindrocopturus furnissi Buchanan	Furniss, 1942	Pacific, N.W., Amer.
Perilitus			
P. areolatus Thomson	CHRYSOMELIDAE		
	Phyllotreta atra Fab.		
	P. cruciferae Goeze		
	P. diademata Foudr.	Newton, 1931	England
	P. consobrina (Curt.)		
	P. nigripes (Fab.)		
	P. undulata Kutsch.		
P. coccinellae Schrank	COCCINELLIDAE		
(*terminatus* Nees)	*Adalia frigida* Schn.	Speyer, 1925	Throughout most of Holarctic, Realm & also Fiji, Hawaii, New Zealand and Australia
(*americanum* Riley)	*A. bipunctata* (L.)	Balduf, 1926	
		Goidanich, 1933	
		Ogloblin, 1913	
		Timberlake, 1917	
		Liu, 1944	
	Adonia variegata Goeze		
	Coelophora inaequalis (Fab.)		
	Ceratomegilla fuscilabris Muls.		
	Cycloneda munda Say		
	Hippodamia convergens Guér.		
	H. 5-signata Kirby		
	H. 13-punctata (L.)		
	H. parenthesis Say		
	H. sinuata var. *spuria* Lec.		
	Halyzia 14-punctata L.		
	Macronaemia hauseri Weise		
	Olla abdominalis Say		
	Semiadalia 11-notata Schneid.		
	Coccinella 5-punctata L.		
	C. 7-punctata L.		
	C. 9-notata Herbst.		
	C. 13-punctata		
	C. californica Mann.		
	C. perplexa var. *juliana* Muls.		
	C. fuscilabris		
	C. sanguinea		
P. falciger Nees	MELANDRYIDAE		
	Orchesia micans Panz.	Speyer, 1925, after Marshall, 1887 & 1891	England
	CHRYSOMELIDAE		
	Timarcha coriaria Laich.		
	T. laevigata Duft.		
P. labilis Ruthe	CURCULIONIDAE		
	Sitona spp.	Grossheim, 1928	Russia
	S. lineata L.	Dmitriev, 1935	
	S. crinita Hbst.	Ulashkevich, 1936	
		Jackson, 1928 (?)	England (?)

TABLE 1—(Continued)

Parasite	Host	Reference	Distribution
P. leptosi Viereck	*Leptops hopei*	Ferriére, 1931, after Farrel, 1919	Australia
P. mylloceri Wilkn.	*Mylloceras undecimpustulatus* var. *maculosus* Desb.	Fletcher, 1930	Pusa & Bihar, India
P. omophli Lesne	ALLECULIDAE *Omophlus caeruleus*	Lesne, 1892	Algeria
P. pyri (Viereck) (May be same as *rutilus* Nees)	Not known	Muesebeck, 1936	Conn. & N. J., U.S.A.
P. rutilus Nees	CURCULIONIDAE *Sitona lineata* L. *S. hispidula* Fab.	Jackson, 1928	England, (all Europe (?)
P. strenuus Marshall	Not known	Kloet & Hincks, 1945	England
P. stuardoi Porter	COCCINELLIDAE *Adalia bipunctata* L. *A. deficiens* Muls. *Eriopis connexa* Germ. *Cryptolaemus montrouziere* Muls.	Cortés, 1941	Chile
**plumicornis* Ruthe	ANTHICIDAE *Notoxus monoceros* L.	Görnitz, 1937	Germany
**vaginator* Wesm.	Not known	Ferriére, 1931	Br. Museum (?)
**Perilitus* sp.	CHRYSOMELIDAE *Psylloides chrysocephala* L.	Kaufmann, 1923	Germany
**Perilitus* sp.	CURCULIONIDAE *Anthonomus pomorum* L.	Speyer, 1933	Germany
**ruficollis* Cameron	Not known	Zoo Record, 1906	S. Africa
**brunneus* Niezabitowski	Not known	Zoo Record, 1912	Poland
**nigriventris* Niezabitowski	Not known	Zoo Record, 1912	Poland
**transsylvanicus* Endre	Not known	Zoo Record, 1928	Hungary

NOTE: Host names listed are essentially those given by the authors cited. In a few cases where it has been omitted, the authority was added.
*—Names so preceded probably belong to *Microctonus* rather than *Perilitus*.

Szépligeti (1904) lists 24 species not included above, 19 for Europe and 5 for South America, under the genus *Perilitus* and three additional species from Europe under the genus *Dinocampus*. All of the currently designated *Microctonus* (known at that time) are listed as *Perilitus*, but he includes under this genus two species of the true *Perilitus*. His list of *Dinocampus* does not include any of the true *Microctonus* mentioned above. It would thus appear that most of these would now fall within the latter genus. It is not known, however, how many of these

species remain valid under the genera *Microctonus* and *Perilitus*. He gives no record of hosts species.

Insofar as their habits are known, the species of these two genera are beneficial excepting the two species which attack Coccinellidae and the one that parasitizes *Galerita*. Adult beetles of the families Curculionidae and Chrysomelidae are their most frequent hosts. Several species are rated as primary controlling factors of certain flea beetles.

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A NOTE ON THE DISCOVERY OF A RARE BAT FLEA IN OHIO

(SIPHONAPTERA: ISCHNOPSYLLIDAE)

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A recent discovery of a single female specimen of the rare bat flea, *Eptescopsylla chapini* (Jordan), taken from a big brown bat, *Eptesicus fuscus* (Beauvois), in Hocking County, Ohio, is worthy of special mention.

The collection and subsequent identification of bat fleas is an exceptional occurrence. Bat fleas are rare and are seldom encountered even on careful inspection of many specimens of their hosts. In the United States all of the fleas found associated with the Chiroptera have been classified in the family Ischnopsyllidae. Members of this family are quite striking in their appearance and are easily separated from species of other families of the Siphonaptera by conspicuous morpho logical characteristics.

Eptescopsylla chapini was described by Karl Jordan in 1929, although at that time he placed it in the genus *Nycteridopsylla*. Jordan's specimens were taken from *Eptesicus fuscus* at Glen Echo, Maryland, and consisted of two males and two females. Fox (1940) presented the only other record in the literature of the collection of this species of flea. His specimens were taken from the cave bat, *Myotis sodalis* Miller and Allen, at Colossal Cave, Kentucky and consisted of one male and five females. Fox (1940) erected a new genus, *Eptescopsylla*, for this parasite and designated it the genotype.

The present paper reports a third collection record of *Eptescopsylla chapini* and notes the first time that this species has been taken in Ohio. The Ohio specimen was collected by Robert M. Goslin on March 2, 1951, and is deposited in the Ohio State Museum, Columbus, Ohio.

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NOTES ON ORCHIDACEAE COLLECTED IN ATHENS COUNTY, OHIO

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The following list of orchids of Athens County is taken from the herbarium sheets in my collection at Athens High School; the notes are from my own observation and experience; the orchids are classified and numbered according to the system of the Ohio State University Herbarium. The name, according to the International Code, is included in parenthesis. The dates given are the dates when first placed in my herbarium. Recent observations have been made and most of the stations are still intact.

I have not listed *Cypripedium parviflorum* Salisb. (*C. calceolus* L. var. *parviflorum* (Salisb.) Fern.) Yellow Lady's slipper, or *Fissipes acaulis* (Ait.) Small (*Cypripedium acaule* Ait), Moccasin Flower, because I have not collected them in Athens County. Both are listed in the Ohio University Herbarium. Mr. Leonard L. Stephenson, of Buchtel, Ohio, has collected *C. parviflorium* but not *F. acaulis* in Athens County. Dr. William C. Stehr and Dr. A. H. Blickle, of Ohio University, reported seeing both in Athens County. My grandfather collected both of them on the outskirts of Athens. Ohio, forty-five years ago.

It seems to me that Athens County has a wide variety of flora, and that this list of orchids represents a rather large variety of species.

1. (639) *Galeorchis spectabilis* (L) Rydb. (*Orchis spectabilis* L.) Showy Orchis. 5/16/37. Common in damp woods, usually in beech woods. Not plentiful but no difficulty finding specimens in woods close to Athens, Ohio, at present time. It has a delightful odor, the only orchid I know of which does have an odor.

2. (643) *Gymnadeniopsis clavellata* (Mx.) Rybd. (*Habenaria clavellata* Mx.) Spreng. Green Wood Orchis-Edge of pine planting near swampy area, climbing fern, *Lygodium palmatum*, and club moss *Lycopodum clavatum* nearby.

3. (648) *Blephariglottis lacera* (Mx.) Farw. (*Habenaria lacera* (Mx.) Spreng) 7/21/40. Ragged fringed Orchis. Marshy hillside near The Plains, Ohio. A small area with plants unusual to the locality including *Filapendula rubra, Pteris aqulina* L., *Ilex verticellata* (L), *Micranthes pennsylvanica* (L). This is the southermost record for *M. pennsylvanica* in Ohio. Another station for *B. lacera* is Carthage Twp. shown to me by Harold Moore.

4. (650) *Blephariglottis paramoena* (Gr.) Rydb. (*Habenaria peramoena* Gray). Fringeless Purple Orchid. Open swampy areas. One station, now being obliterated, still showed one specimen at edge of city street in Athens, Ohio, in July, 1951. It disappears with the coming of shrubby growth in the swamps. It also seems to come and go in an area in five to seven year cycles.

5. (654) *Ibidium cernuum* (L) House (*Spiranthes cernua* (L) Richard) 9/18/38. Nodding Ladies Tresses. In moist ground, grassy area. One station back of U. S. Forestry Station, Athens, Ohio. Another at Izaak Walton Farm, Waterloo Twp. Athens County, Ohio. Fairly common.

6. (655) *Ibidium ovale* (Lindl.) House (*Spiranthes ovalis* Lindl.) 9/26/37. Oval Ladies Tresses. Athens Twp. Pittsburgh Coal Co. land west of Athens, Ohio. I have found this orchid to be more common in pawpaw thickets. Stations still intact. Winter leaf still green at inflorescence, collected with Mr. P. S. Wamsley.

7. (658) *Ibidium gracile* (Bigel.) House (*Spiranthes ovalis* Lindl.) 7/30/39. Slender Ladies Tresses. Open dry grassy area Athens Twp. Found first in 1937 growing on grassy bank in my backyard at Athens, Ohio with E. N. Mills. Common.

8. (659) *Ibidium beckii* (Lindl.) House (*Spiranthes tuberosa* Raf.) 8/7/37. Little Ladies Tresses. Waterloo Twp., Enderlin Forest, and Izaak Walton Farm. The Enderlin specimen growing in open space in pine planting. The Izaak Walton specimen in grassy area at edge of oak woods. Not common in this area. Seems to like more moisture than some of the other members of this genus. It has a more slender stem than the Slender Ladies Tresses. Several of this species given to me by Leonard L. Stephenson at Buchtel, Ohio, where it is more common.

9. (660) *Peramium pubescens* (Willd.) Mac. M. (*Goodyera pubescens* (Willd) R. Br.). Downy Rattlesnake Plantain common in Athens County. Found in oak woods and pine plantings. No collection date on herbarium specimen. The winter rosette with its white lines makes a nice showing in the winter woods. Common.

10. (665) *Isotria verticellata* (Willd.) Raf. May 10, 1936. Whorled Isotria. Found in Enderlin Forest at Carbondale. Growing among pine, also among hard woods at edge of planting. Not common in Athens County.

11. (666) *Malaxis unifolia* Mx. Green Adder's mouth, July 6, 1935. Growing in pine planting at Carbondale, Ohio. Common in pine in Enderlin Forest at Carbondale and at Waterloo State Forest.

12. (667) *Liparis liliifolia* (L) Rich. May 27, 1937. Large Tway Blade. Growing in swampy area at Izaak Walton Farm in Waterloo Twp. Subsequent specimens found in beech woods and some in dry situations. Some argument about the first specimen but I could not convince anyone that it was the Fen Tway Blade.

13. (669) *Tipularia unifolia* (Mihl) BSP (*Tipularia discolor* (Pursh) Nutt.). Crane-fly Orchis. Waterloo Twp. Found in beech woods at Enderlin Forest and Izaak Walton Farm. Identified in winter by its one green leaf, purple on the underside. May be missed easily when in bloom.

14. (670) *Aplectrum hymale* (Muhl.) Torr. May 15, 1937. Putty-root. Athens Twp. Rowlands Farm. Usually in partial shade at edge of woods. Fleshy corm tastes like putty probably does.

15. (672) *Corallorrhiza maculata* Raf. August, 1939. Large or spotted coral-root. Waterloo Twp. Beech woods. One specimen for Athens County.

16. (673) *Corallorrhiza wisteriana* Conrad. 4 26 38. Wister's Coral Root Athens Twp. Peach Ridge near Athens, Ohio. I found this plant first growing in middle of an old path in beech woods. Mainly in open places among dead leaves. It blooms very early in the spring and is soon gone.

17. (674) *Corallorhiza odontorhiza* (Willd) Nutt. 10 5 36. Small-flowered or Late Coral-root. Waterloo Twp. Common in pine woods in Athens County. A very late bloomer. I have found it in bloom in November.

History of the Theories of Aether and Electricity. *Sir Edmund Whittaker.* Philosophical Library. New York. 1951.

This work by the famous British mathematician and natural philosopher is a much augmented and modernized version of his previous book on the same topic published in 1910. It covers the history of the aether theories of light from Descartes to the beginning of the 20th century. The new development of the theory of light and electricity which we owe to Einstein since 1905, and to quantum dynamics since the 1930's is to be covered in a second volume by the same author which, for the present day reader, will prove of even greater interest. The efforts of more than two centuries devoted to a rational theory of the aether today look but like the overture to a drama unfolded during our own lifetime, and Whittaker's representation does not lack dramatic suspense. It is unfortunate that most professional physicists whose training would enable them to appreciate a work such as Whittaker's, tend to postpone their historical studies until a time when they themselves, like Sir Edmund, will be free of professional duties, whereas non-specialists interested in the historical development of scientific ideas will have some difficulty in following the detailed course of development from vague and generalized hypotheses to far-reaching and consistent theories reported in this monumental work.

ALFRED LANDÉ

THREE NEW SPECIES OF TYPHLOCYBINE LEAFHOPPERS FROM MEXICO

(HOMOPTERA: CICADELLIDAE)

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Several genera are represented in the Mexican Cicadellinae. Genera containing several species have been treated separately. Three genera, *Parallaxis*, *Typhlocybella*, and *Typhlocyba*, each contain one new species and these three are treated together in the following pages. The types are in the DeLong collection, the U. S. National Museum, and the Snow collection located at the University of Kansas.

Parallaxis diffusa n. sp.

Resembling *guzmani* (Baker) in general form and appearance. The coloration on the pronotum and elytra is not condensed into spots but rather forms a mottling of light and dark brown. The face and venter are light cream to tan. Length 2.5 mm.

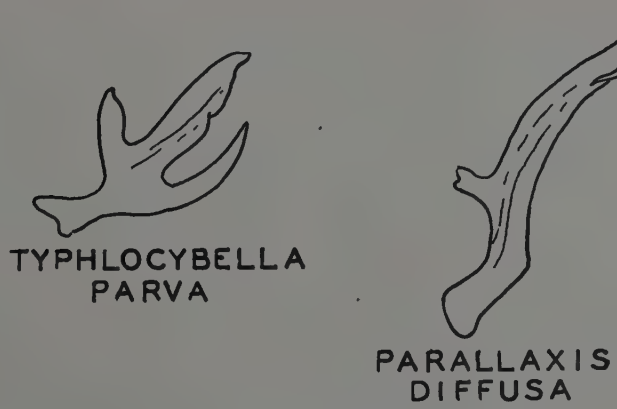

FIGURE 1. Lateral view of aedeagus of species as labeled.

Genitalia: The genital capsule and styles resemble those of *ornata* but the apices of the pygofers are produced into small, triangular lobes. The aedeagus is slender and erect and bears a pair of lateral and a medial, reflexed processes at its apex.

Holotype male and paratype males from Santa Engracia, Mex., Nov. 5, 1938, Caldwell; paratypes El Mante, Tamaul., Aug. 9, 1930 (MF 1734), Dampf; Iguala, G'ro., Sept. 11, 1939, DeLong and Plummer; Valles, S.L.P., Sept. 24, 1941 and Tamazunchale, S.L.P., Sept. 25, 1941, DeLong, Good, and Caldwell. Types in the DeLong collection.

Typhlocybella parva n. sp.

Strongly resembling *minima* Baker in general form and appearance but with distinctive genitalia. The coloration of both species is nearly identical but the elytra of *parva* has flecks of brown along the veins which are lacking in *minima*. Length 2.4 mm.

Genitalia: The genital capsule and styles resemble those of *minima*. The dorsal processes of the aedeagus are short and slender, the phalicata is nearly straight, and a median ventral process arises on the base and extends parallel to the phalicata.

Holotype male and male paratypes collected at 430 km south of Mexico City, G'ro., Dec. 27, 1949 by R. H. Beamer. Types in the Snow collection.

Typhlocyba aureolineata n. sp.

A beautifully marked species which resembles *hubbardi* (McA.) in general form and appearance but with distinctive coloration. Length 2.8 mm.

Color: Vertex, pronotum, and scutellum are a uniform black. The dorsal half of the face and the pygofers are black while the ventral half of the face, the sides of the pronotum, and the venter are white. The distal half of the corium, except for scattered hyaline spots, and the anterior margin of the clavus are black. The clavus and the anterior half of the corium are white crossed by a broad, transverse, metallic-golden band.

Known only from the female. Holotype female collected at Valles, S.L.P., Nov. 7, 1942, by DeLong, Good, and Caldwell; paratype female collected at Santa Engracia, Mex., Nov. 8, 1938, by J. S. Caldwell. Types in the DeLong collection.

Invertebrate Fossils. *Raymond C. Moore, Cecil J. Lalicker, and Alfred G. Fischer.* McGraw-Hill Book Company, Inc., New York. 1952. xii+766 pp. $12.00.

In the field of Invertebrate Paleontology, the teacher is faced with something of a dilemma when it comes to the choice of a text. Few texts are available to him and all of them are more than 15 years old. It is rather remarkable that the last two decades have produced so few texts in the field of paleontology whereas other branches of science seem to suffer from a plethora of them. It would be curious to examine the reasons for such a lack of manuals; one suspects that the prospective author starts out with good intentions, begins to gather information, outlines his chapters, and then gets down to the business of putting flesh and muscle on the bare skeleton. Perhaps it is at this point that he realizes the enormous amount of material which he must incorporate into his text, the variety of publications in all living languages which must be considered in order to have an up-to-date treatment of the subject. Then too, unless he is himself an artist of no mean ability, the illustration of a text of this sort presents him with other difficulties. It may be at this point that our hypothetical author throws up his hands in despair and abandons his project.

It is refreshing to find, therefore, that in spite of difficulties, in spite of the enormous amount of work involved, Professor Moore and his colleagues have persevered to the end and completed a task of such monumental proportions. The result is a complete, clear, yet concise treatment of a subject which is of interest not only to paleontologists themselves but to all geologists, zoologists, geneticists, and students of evolution.

Some of the difficult groups of fossils on which much research has been done in the last quarter century receive adequate treatment for the first time in a book intended for the beginning student. Picking a few at random, the Pleosponges, Conularids, Tintinnids, and Graptolites are here discussed in the light of recent work. This may not be a world-shaking event, yet the interpretation of these organisms in the past has led to several erroneous conclusions concerning not only paleontology but also evolution, paleoecology, and the geologic age of certain living groups of invertebrates. Their treatment in this text will be a revelation to those whose acquaintance with invertebrate paleontology dates back 15 or even 10 years.

From the standpoint of the teacher, this book has many advantages. Its organization is simple, yet clear and logical; the illustrations, all line-drawings, are worth many pages of text; the references at the end of each chapter, both plentiful and up-to-date, provide a veritable mine of auxiliary information.

From the standpoint of the student—and the term is here taken in the broader sense—it will have a usefulness which will persist long after the period of formal classroom acquaintance with it. It is a book which the field geologist, the teacher, and the amateur will turn to again and again for enlightenment and guidance.

A. La Rocque.

AGE OF FRINGE DRIFT IN EASTERN OHIO

WILBER STOUT
Route 3, Rock Mill, Lancaster, Ohio

During Pleistocene time or the "Great Ice Age" the surface of much of the United States was greatly modified by a series of ice invasions and by resulting changes in the drainage systems. The order and the effect of these events are still subjects for geological discussion. Yet many facts may be interpreted from a careful study of the deposits and of the marks of erosion left on the old surface. Here, mainly, only Ohio is concerned.

EARLY MAJOR STREAMS

As far as known the original drainage in the Appalachian field in western Pennsylvania, parts of Virginia and North Carolina, most of West Virginia, northeastern Kentucky, and southern and central Ohio was by two major streams of Teays age, the Pittsburgh and the Teays rivers. The general courses of these old streams are readily traced as they left definite impressions on the old land surface. Here they need be discussed only briefly.

PITTSBURGH RIVER

The basin of the Pittsburgh River was largely that now drained by the Allegheny and the Monongahela rivers and by minor streams of northern West Virginia and of eastern Ohio. In the latter area the western boundary of this old basin is marked by the Flushing escarpment. The course of the Pittsburgh River has been traced rather carefully by many workers.[1] This ancient stream flowed northwestward from its formation by the junction of two rivers at Pittsburgh to Beaver, then northward past Beaver Falls and Wampum to New Castle where the stream was dammed by glacial drift. Beyond this its course is less definite but accumulating data indicate that it flowed on northward to the basin of Lake Erie and then by some course not defined, on to the sea.

TEAYS RIVER

The Teays River, the type stream for this stage of drainage, gathered its headwaters in the Appalachian Mountains and the Piedmont Plateau in Virginia and North Carolina and then flowed northward in the "ridge and valley" terrain to White Sulphur Springs, Virginia. Here this old stream cut through the mountains and plateau to Charleston, West Virginia, then traversed the broad abandoned valley, well outlined, past St. Albans and Barboursville to Huntington. Its course was then down what is now the Ohio Valley to Wheelersburg, Ohio, then it turned northward past Minford, Beaver, Waverly, and Richmondale to Chillicothe where the old bed is buried by both the Illinoian and Wisconsin drifts. Through scattered evidence, but with some assurance, its way is traced northwestward from Chillicothe past Clarksburg, London, Vienna, Springfield, St. Paris, and St. Mary's to the Ohio-Indiana state line near Rockford.[2]

CHARACTER OF OLD TEAYS STREAMS

The streams of the old Teays System were quite mature. Their gradients were low, the valleys wide, the bordering hills well rounded, and the uplands

[1]Traced by Foshay, Chamberlin, Leverett, Hice, Campbell, and Lamb.

[2]For more definite information see Bulletin 44, Geological Survey of Ohio. Also considerable work has been done on this old waterway in Indiana.

thoroughly dissected. They are readily recognized by their position above the present drainage and commonly by deposits of Minford silt.

EARLY GIACIER

The original drainage cycle, the Teays, was brought to a close by an early glacier, probably continental in extent. As here concerned this ice invasion closed the northward passage of the old Pittsburgh River near New Castle, Pennsylvania. Nearby in eastern Ohio the border of the moraine is rather definitely marked from Section 25, Middleton Township, Columbiana County, westward past Clarkson and Dungannon to Kingston, then more irregularly past Mapleton to North Industry where this older drift is buried by that of Wisconsin age. From the effects on the old Teays streams in central and western Ohio this glacier evidently passed on westward across Ohio and on into Indiana, and probably to the Mississippi Valley. This glacier definitely closed the Pittsburgh River near New Castle, Pennsylvania, and most assuredly the Teays River somewhere in western Ohio. Thus it closed the Teays drainage stage and inaugurated a new cycle. Note also that from the known data this is the first drainage disturbance evident in the area.

This "fringe drift" in eastern Ohio is generally thin, not often more than a few feet in thickness. It appears to be only the remnant of a much thicker sheet, which through long weathering and erosion lost much of its volume and most of the common drift features. The border lacks sharpness and definition, the exact boundary often being difficult to determine. The materials are highly weathered; even the granite boulders are much decayed. In every way this fringe drift shows great age.

DEEP STAGE DRAINAGE

The closing of the old Pittsburgh River and that of the Teays River by this early glacier inaugurated the second system of drainage as the waters from those two basins had to find new outlets to the sea. The second drainage cycle is known as the Deep Stage as the valley floors were cut far below those of the Teays stage and now stand below the levels of the present streams. Due to the damming of the Pittsburgh River near New Castle by this early glacier the waters of this basin were deflected southwestward along a tributary of the old Pittsburgh River and then over a col at Sardis into the basin of the Teays River. Then the combined waters from both basins found passage on westward over the Manchester col to the basin of an old stream near Cincinnati and then on to the Gulf.

In such radical changes the *immense amount of work done* and the *long time required* must be duly considered. Thus a great new valley from Pittsburgh to Cincinnati, at least, was excavated not only deep but wide through the resistant rocks. Some 50 or 60 percent of what is now the Ohio Valley was cut during Deep Stage time, hence of long duration.

The features of the Deep Stage drainage are very evident in all the unglaciated part of Ohio and in some areas stand out prominently. In fact the Teays and Deep Stage features are just as apparent as the drifts. Deep narrow valleys are especially conspicuous throughout the old basin of the Pittsburgh River in Columbiana, Jefferson, Harrison, Belmont, and Monroe counties or in the area east of the Flushing escarpment. In the remainder of the unglaciated part of Ohio the same features are apparent, but owing to the Teays basin being more reduced, show in a somewhat less striking way. Thus all valley in the unglaciated part of Ohio exhibit the Deep Stage influence to a marked degree. The Deep Stage drainage inaugurated by the "fringe drift" was cut entirely before the advent of the Illinoian glacier and from the immense amount of work done certainly extended back through Aftonian time to the Nebraskan glacier.

POMEROY-CINCINNATI RIVER

In part the new major Deep Stage stream, the Pomeroy-Cincinnati River, followed the tributaries of the older streams but through long reaches the Deep Stage erosion cut through highland areas with little regard to the older passageways. Everywhere the new valley was cut far below the Teays levels and it was widen to practically the limits of the present Ohio, about one and one-fourth miles. In fact little work has been done on excavating this valley since Deep Stage time. Now consider in more detail some of the work accomplished and the expanse of time required for such a tremendous task.

At East Liverpool the Deep Stage Pomeroy River was cut some 313 feet below the Teays Stage level, at Toronto 360 feet, at Wellsburg 395 feet, and at Powhatan over 400 feet. From the last place to New Matamoras, over the Sardis col, and through the "long reach," from 400 to 500 feet of shales, sandstones, and limestones were excavated to provide passageway for the new stream. From New Matamoras past Marietta to Point Pleasant the younger Pomeroy River used the trough of the old Teays Stage Marietta River but lowered the floor some 200 feet through massive sandstones, shales, and limestones.

From Point Pleasant to Pomeroy and even on to Huntington the course of the new stream was mainly through the uplands, over cols and along minor valleys of the older Teays system. Hence, through this part of the course of the Pomeroy-Cincinnati River much work, with little aid, was accomplished in carving out a great valley in resistant rocks. At Huntington the old Teays Valley proper was encountered by the Cincinnati River and then this course was used, but not entirely, for the younger waterway.

At Wheelersburg, the old Teays River flowed northward and the Cincinnati westward. The best place known to the writer to make an appraisal of the events of glaciation and those of drainage modifications is from the Sun Hill near Wheelersburg, Ohio. Here the Lexington peneplain, apparently the original land surface and quite evident, stands at an elevation not far from 940 feet. Assuming that the original drainage systems began with the uplifting, by the Appalachian Revolution, of the land surface in late Permian time, then through the long geological ages—Triassic, Jurassic, Cretaceous, and Tertiary—the waterways, such as the Teays, were developed and had reached maturity, that is, the valleys were wide, the uplands thoroughly dissected and the bordering hills well sculptured. Now on Dogwood Ridge near Wheelersburg the rock floor of the old Teays River is present at an evelvation close to 650 feet. Hence in four geological ages the Teays River had excavated a valley 290 feet deep (940 — 650 = 290) and about 1¼ miles in width through Pottsville and Waverly rocks. This then, as a measure, may be taken as the work done by that original stream in four geological ages.

Next consider the work done by the Deep Stage stream. Even considering some elevation of the land surface and of shortening the way to the sea, the work done in excavating the new waterway, the Cincinnati River, was large for at Wheelersburg its floor was eroded 190 feet below that of the Teays (650 — 460 = 190) and its valley was widened to 1¼ miles. Now the question arises: if it took four geological ages to erode the old Teays waterway, 290 feet deep and 1¼ miles wide, how long did it take to carve that of the new Deep Stage stream, 190 feet deep and 1¼ miles wide. With this measuring stick and under any consideration the time required to do such an immense amount of work on the Deep Stage stream was long and most assuredly extended back through Aftonian time to the Nebraskan ice invasion. Consider also that this was about the smallest amount of work the new stream was required to do for it had to cut through cols and uplands throughout much of its course.

From here the Cincinnati River cut through the Sciotoville Col, entered the basin of the old Portsmouth River and then passed on southwestward over the Manchester Col to the basin of an ancient stream near Cincinnati. Much of

this terrain consists of hard sandstones and dense carbonaceous shales, so degradation of the great valley here was no easy task.

In review, considering Ohio alone, the Deep Stage Pomeroy-Cincinnati River was cut over 300 miles in length, far below the levels of the older Teays Stage streams, and on an average over one mile wide. In places the degradation of the course had little or no help from earlier streams. This interglacial period lasted sufficiently long to form most of the valley we now know as the Ohio. Further, the cutting was done through all kinds of rocks such as shales, sandstones, limestone, clays, and coals, many hard, massive, and resistant. Under any consideration the time required was long, measured at least in hundreds of thousands of years, if not in millions.

NEWARK RIVER

Also in this discussion the Newark River of Deep Stage age, must be considered briefly. Its main waterway was cut through several basins of the older streams and its bed was also excavated much deeper. Further, cols were cut away and locally complete new intrenchments were made. Through the action of this early glacier the waters from the north-flowing Dover River, in east central Ohio, were diverted over the divide at Gnadenhutton to the basin of the Cambridge River and then along this and related waterways past Coshocton, Trinway, Frazeysburg, Newark, Canal Winchester, Groveport, Ashville, and Circleville to Chillicothe. At the last place it crossed the old Teays Valley, cut a new channel to Higby, skirted old streams past Waverly, Piketon, and Lucasville to Portsmouth where it united with the master stream, the Cincinnati River.

Again the amount of work done on the Newark River of Deep Stage age was large as may be shown by a few examples. The difference in levels between the older and the newer streams is about 190 feet at Portsmouth, 150 feet at Waverly, 90 feet at Chillicothe, 90 feet at Canal Winchester, 100 feet at Newark, and 100 feet at Newcomerstown. The amount of work done; that is, in digging a new valley 100 feet or more below the older drainageways, locally in excavating complete new channels, in widening the valley much beyond that of the older ones, and in doing this in resistant rocks, required a long, long period of time. It certainly reached back to early Pleistocene times.

A REVIEW OF EVENTS

Let us review the events that have happened so far in glaciation and stream changes in this part of the field.

(1) The original or oldest known drainage in the region was that of Teays Stage time. The chief streams were the Pittsburgh and the Teays rivers.

(2) These streams were dammed by a glacier, probably continental in extent.

(3) Prior to this no stream disturbances have been noted. Hence this glacier was evidently the first or oldest in the region.

(4) Thus this early drift—the "fringe drift" glacier of eastern Ohio—closed the Teays Stage cycle and inaugurated the Deep Stage cycle.

(5) The Deep Stage cycle was of long, long duration as an immense amount of work was done in excavating some 50 to 60 percent of new valleys like that of the Pomeroy-Cincinnati River, now the Ohio, and the Newark River. These waterways were cut deep and wide.

(6) This old drift in eastern Ohio, profoundly weathered indicates an age comparable to that required to cut the Deep Stage streams.

(7) Hence, the glacial invasion and the inauguration of the Deep Stage drainage are events young in Pleistocene time, Nebraskan in age.

ILLINOIAN GLACIER

The next event of importance in this series of changes was the advance of the Illinoian ice sheet into central and western Ohio. This closed the Deep Stage

drainage cycle and opened a new one, the Post-Illinoian. As commonly recognized the boundary of the Illinoian glacier extended in a general way from Ashland County southward past Brinkhaven, New Guilford, Hanover, Gratiot, Sugar Grove, Chillicothe, Bainbridge, and Seaman to the Ohio River at Ripley. At the latter place the ice sheet crossed into Kentucky and by so doing blocked the Deep Stage Cincinnati River and thus inaugurated a new cycle of drainage, here not necessary to describe for this treatise.

Wheelersburg is also a good place to make an appraisal of the work done by both the Illinoian and the Wisconsin ice sheets. The main results from the Illinoian ice invasion and from stream activity during Sangamon time was to first fill the Deep Stage drainage-ways with sand and other debris to the level of the sand terraces found along both the present Scioto Valley and along that of the Ohio. Remnants of these are present north of Sciotoville, Ohio, and near Siloam Church, Kentucky. These terraces now stand at an elevation approximating 580 feet or 120 feet above the Deep Stage floor at 460 feet and 70 feet below the Teays level at 650 feet. Thus the work done during Sangamon time was comparatively small and was aggrading and not erosive.

The Wisconsin ice invasion which crossed the state, again caused some changes in the drainage patterns. The chief effect as far as the old waterways are concerned is relatively unimportant. Outwash of gravel and other sediments filled the valleys eroded in the Illinoian sand terraces to the flood plain terraces now standing at about 550 feet at Sciotoville.

In review of the evidence near Wheelersburg, practically all the work done in cutting the great valley now known as the Ohio was accomplished either in preglacial Teays time, before the Nebraskan glacier, or during the Deep Stage erosion cycle, that is Aftonian, following this early ice invasion. The Illinoian and Wisconsin glaciers enter little into the picture, their work being mainly aggrading.

RESULTS OF THE CHANGES

In this discussion, from these events the important things are:

(1) The Illinoian glacier buried much of the Newark River of known Deep Stage time

(2) It closed the Deep Stage outlet, that of the Cincinnati River.

(3) It left a set of sand terraces below the drift border along what is now the Scioto and Ohio Rivers.

FURTHER CONSIDERATIONS AND ASSUMPTIONS

Now consider these facts:

(1) If the "fringe drift" in eastern Ohio is Illinoian then the Illinoian glacier inaugurated the Deep Stage drainage—by closing the Pittsburgh River—and after an interglacial period of at least hundreds of thousands if not millions of years—closed the same cycle by burying the Newark River and part of the Cincinnati. It would thus open and close a drainage period of very long duration. Impossible.

(2) On such an assumption if the "fringe drift" is Illinoian then it closed the Teays stage and again after a long, long period of erosion closed the Deep Stage. Impossible.

(3) Also if that eastern Ohio "fringe drift" is Illinoian then this ice sheet closed the three known water gaps, the Pittsburgh and Teays outlets of Teays time and the Cincinnati River outlet of Deep Stage time. No other outlets are known in the entire basin. Where did the water go?

(4) If the Illinoian drift of central Ohio and that of the "fringe drift" in eastern Ohio are of the same age then why is that in eastern Ohio profoundly weathered and that in central Ohio comparatively fresh?

CONCLUSIONS

When the age of the original streams, time of first stream disturbance, the immense amount of work done during the Deep Stage cycle, the severity of weathering of the "fringe drift" of eastern Ohio, the burial of the Deep Stage Newark River by known Illinoian drift, the closing of waterways, and other factors, are considered, the "fringe drift" of eastern Ohio cannot be younger in age than Kansan and from most of the evidence it is Nebraskan. Most assuredly it represents the oldest continental glacier in this region and cannot be Illinoian. In general those views are also held by others.[3]

LITTLE BEAVER CREEK

Since the age of the "fringe drift" in eastern Ohio is under consideration the data within Columbiana County should be duly appraised. Here much evidence is apparent and some of it is quite conclusive in fixing the time of glaciation and of the erosion cycles. (See *Wellsville* topographic sheet for references.)

As previously shown, the border of the "fringe drift" as it extends westward from Pennsylvania, enters Ohio in Section 25, Middleton Township, Columbiana County. From here the border is traced on westward by the village of Clarkson, then across Elk Run, Madison, and Center Townships, and past the villages of Dungannon and Kensington in Hanover Township to Section 36, Paris Township, Stark County. The trend of the moranic border is thus nearly east-west.

Next the original streams and their patterns should be considered carefully. The course and marks left by Negley Creek, a tributary of the old Pittsburgh River, can be identified with some assurance. This preglacial stream followed what is now the course of West Fork from Millport past Gavers to West Point. Some small shoulders of the old rock floor are evident at elevations near 975-980 feet. On eastward at Campus the floor of the preglacial Negley Creek is well preserved. Its elevation is not far from 972 feet. From Campus to Saint Clair much of the original stream bed has been obliterated by later erosion but sufficient remnants are left to mark the original course. Much the same condition is found north of Saint Clair where Negley Creek followed in what is now the valley of North Fork to Negley then eastward to the old Pittsburgh River. Supporting evidence for the course of the preglacial Negley Creek is provided by the direction of flow of Longs Run, Calcutta Run, Bieler Run, and many minor streams.

Now this preglacial stream, Negley Creek was blocked by the "fringe drift" just north of Saint Clair and hence the waters of this basin had to find a new passageway as an outlet. The course taken by the ponded waters was southward from Saint Clair along a small stream and over a col in Section 13, Saint Clair Township, to the headwaters of another small stream near Grimms Bridge. From here it traversed a winding course on to the newly formed Deep Stage master stream, the Pomeroy-Cincinnati River. (For a description of the valley from Saint Clair to Martins Ferry see Bulletin 28, Geological Survey of Ohio, pages 30-31.) This passageway is not a col but a gorge-like valley more than seven miles in length and from the rim of the highlands some 400 feet in depth. The new stream cut across the prominent Wellsville anticline and excavated its way through massive sandstones and other resistant rocks. Under any consideration the time required to do such an immense amount of work was long.

From the data afforded by the surface features in Columbiana County what are the facts revealed by these cycles of glaciation and drainage? The chief ones may be summarized as follows:

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[3]See Wayne, William T., and Thornburg, William D.; Bull. No. 5, Geol. Survey of Indiana.

SUMMARY

1. The "fringe drift glacier" in this area blocked the northward passage of preglacial Negley Creek, tributary of the old Pittsburgh River.

2. The "fringe drift glacier" inaugurated the Deep Stage cycle of drainage and hence was responsible for the new stream and the deep gorge from Saint Clair to Martins Ferry.

3. This was no easy task for the gorge cut by this little stream is more than seven miles in length and some 400 feet in depth and was excavated across the Wellsville anticline and through resistant rocks.

4. The time required to cut such a passageway certainly required all of Aftonian time or it reached back to the Nebraskan glacier.

5. These occurrences all preceded the advent of the Illinoian glacier which later closed the Deep Stage erosion cycle.

6. From such data the "fringe drift" in eastern Ohio is Nebraskan. It cannot be Illinoian.

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BOOK NOTICES

Physiology of the Fungi. *Virgil Greene Lilly* and *Horace L. Barnett.* McGraw-Hill Book Company Inc. New York. First Edition. 1951. xii+464 pp. $7.50.

The authors have recognized a need for an introduction to the literature as well as an advanced textbook in this much neglected field. As a specialized subject they rightly assume the students familiarity with the structure of fungi and a reasonable background in biological subjects and related sciences.

The discussions of fungal physiology are excellent, though brief. The treatment of the essential metallic elements, vitamins, fungi as test organisms, and action of fungicides and sporulation is especially timely and noteworthy. Excellent reference material is recommended.

The reviewer regrets that in a book of such limited size and great interest, so great a part is devoted to general background information which the authors assume in their introduction that the student already possesses. Reference is made to such topics as units of expressing composition, methods of presenting results, the general treatment of enzymes, carbohydrates, the definition of and determination of hydrogen ion concentration, all of which are available in more complete form in standard physiology texts which the students have undoubtedly studied previous to embarking on this advanced or graduate course.

ATWELL M. WALLACE

Carolina Quest. *Richard M. Saunders.* University of Toronto Press, Toronto, and University of South Carolina Press, Columbia. 1951. First Edition. xi+119 pp. Wood Engravings by *Sylvia Hahn.* $3.50.

Carolina Quest is a delightful account of a historian-naturalist's trip to South Carolina in search of birds.

This reviewer was greatly impressed by the many picturesque descriptions and comparisons. One has the feeling that the writer has produced a work of especial interest, not so much for its profound scientific value but rather for its feeling. This strange quality arises perhaps from an unexpected admixture of the historical, sociological, and natural history interests of the author.

This book will be of interest particularly to those of us who have a fondness for travel and adventure as release from the tedium of daily routine. It is recommended for classes in ornithology and ecology as collateral reading, and will be welcome addition to every ornithologist's library.

FRED H. GLENNY

French-English Science Dictionary. *Louis De Vries.* McGraw-Hill Book Company. New York, Toronto, London. 1951. Second Edition. xii+596 pp. $6.50.

This dictionary should prove a very helpful reference work for all students of science and particularly for those preparing for fulfillment of the doctorate foreign language requirements. Inclusion of all scientific terms would of course be a practical impossibility, but a glance through the book makes it apparent that the author has made an excellent choice of entries. The listing of many words which have exactly the same spelling in both languages seems superfluous. The author further underestimates the quality of perseverance of the average science student by stating in the introduction that the average science student would easily give up if he does not find the word he is looking for.

A separate list of terms in aeronautics, electronics, radar, radio and television brings this dictionary up-to-date in these newly developed fields. It would be more advantageous if this supplement were incorporated in the over-all listing. The handy format and the clear print make this a very attractive and useful book for any science student or research man.

NICHOLAS MOGENDORFF

Checklist of palaearctic and Indian Mammals, 1758 to 1946. *J. R. Ellerman and T. C. S. Morrison-Scott.* British Museum, London. 1951. 810 pp. 3 £ 5s.

This checklist is a critical revision of the mammals of the Palaearctic region and the Indian and Indo-Chinese subdivisions of the Oriental region, south of 20° N. in Africa and 10° N. in Malaya, and covers the taxonomic studies from the 10th edition of Linnaeus up to the end of 1946. All of the known references, basic to each species, are included in their proper places. Keys to genera and species are provided wherever they appear to be necessary as aids in identification. Otherwise, the descriptive literature is cited.

Useful and essential in any institution doing taxonomic work with mammals, especially for museums. Mainly a research reference.

FRED H. GLENNY.

World Economic Geography. *George T. Renner, Loyal Durand, Jr., C. Langdon White, and Weldon B. Gibson.* Thomas Y. Crowell Company, New York. 1951. x+758 pp. $6.50.

This is an interestingly written textbook designed for an introductory course in economic geography or, as the authors prefer, a course in "geonomics." The authors apparently assume that the students who use it will have had a prior course in physical geography.

The book is profusely illustrated with more than 300 photographs and more than 150 maps and other illustrations. The great number of illustrations makes it necessary that many of them shall be small. Most of the pictures and maps serve their purpose well, although a few of the photographs are not well-chosen and some of them conserve space at the expense of clarity.

The book is organized in four parts. The first is brief and consists of a statement of principles and general back ground. Part 2 considers the industries of the farm, range, forest, and fishery. The organization of most of this part is based on climatic regions. Part 3 deals with minerals and manufacturing and part 4 deals with transportation and commerce. Each section is introduced by a chapter setting forth the principles governing the types of industry taken up in that section.

The book is well-organized and well-written throughout. One fault is its great volume of content—nearly 750 pages. It is too long for anything less than a five-semester-hour course and the relative lengths of its various parts does not favor its use for two three-semester-hour courses. Its use as a text is further handicapped by the great variation in length of chapters, which range from eleven to thirty-four pages. Still, it is a good book for those who can adjust it to their needs.

LOWRY B. KARNES.

A Laboratory Course in Biology. *James C. Adell and Louis E. Welton.* Ginn and Company, New York. 1951. vi+282 pp. $2.20.

In this book the authors have developed the laboratory or experimental approach to biology to a greater degree than most biology textbooks do. Brief discussions of pertinent facts and principles precede each series of experiments. The experiments are so organized that the student can usually follow through them without reference to other sources of information. However, the experiments are presented in such a way that those students who are really interested will probably be stimulated to do further reading on the various topics. The selection of subject matter is excellent and emphasizes the major phases of biology that affect every-day living. The materials required are generally easily obtainable and within the financial reach of every school. Many items suggested for use can be obtained locally with very little expense. The emphasis throughout the book is on learning by doing. The presentation is refreshingly different from the monotonous work-books and laboratory guides that accompany so many high school and college biology texts. This book offers a challenge to both the teacher and the student to make biology a live and interesting subject.

W. C. STEHR.

Quantitative Chemical Analysis. *Leicester F. Hamilton and Stephen G. Simpson.* The Macmillan Company, New York. Tenth edition, 1952. xvii+529 pp. $4.50.

The tenth revision of this book, formerly *Talbot's Quantitative Chemical Analysis*, includes discussions of theory, laboratory technique, and stoichiometry in well-balanced proportions. Directions for the analytical determinations, while concise, are sufficient to be followed by the student with a minimum of laboratory supervision.

College Physics. *Robert L. Weber, Marsh W. White,* and *Kenneth V. Manning.* McGraw-Hill Book Company, Inc., New York. Second edition, 1952. x+820 pp. $6.50.

This revised second edition of *College Technical Physics* continues the original purpose of the book, namely, ". . . to help students acquire an exact knowledge of basic physical principles and the ability to apply these principles with confidence and facility in the solution of physical problems." The emphasis on problem solving is clearly evident. Calculus notations are avoided in the text, but several important derivations carried out by calculus methods appear in the Appendix.

The Chemistry of Organic Compounds. *James Bryant Conant and Albert Harold Blatt.* The Macmillan Company, New York. Fourth edition, 1952. viii+655 pp. $5.90.

This is an up-to-date revision of a textbook for the first year's course in organic chemistry.

Principles of Chemistry. *Joel H. Hildebrand and Richard E. Powell.* The Macmillan Company, New York. Sixth edition, 1952. xii+444 pp. $4.50. (Also available bound with Reference Book of Inorganic Chemistry. *Wendell M. Latimer and Joel H. Hildebrand.* The Macmillan Company, New York. Third edition, 1952. xii+625 pp. $7.50.)

A textbook which in the authors' words: ". . . does not present one person's notions of how general chemistry should be taught, but is rather the fruit of cooperative effort by members of a large department who have believed that good research and good teaching are equal obligations."

Man and the Biological World. *J. Speed Rogers, Theodore H. Hubbell, and C. Francis Byers.* McGraw-Hill Book Company, Inc., New York. Second edition, 1952. xiv+690 pp. $5.75.

This new second edition includes a wealth of skillfully drawn illustrations not present in the original text. The book is designed for a one-course presentation of biological principles.

Biology: Its Human Implications. *Garrett Hardin.* W. H. Freeman & Company, San Francisco. Second edition, 1952. xii+720 pp. $5.00.

As stated by the author: "The viewpoint throughout this work is that science is more than a collection of facts and theories. In a broad sense, science is one of the humanities, and by no means the least of them . . . "

Blakiston's Illustrated Pocket Medical Dictionary. *Normand L. Hoerr,* Editor-in-Chief. The Blakiston Company, Philadelphia. 1952. xvi+1029 pp. Plain, $3.25; Thumb-Indexed, $3.75.

A new dictionary with full, unabridged definitions of over 33,000 medical terms. The illustrations are grouped together on 24 pages at the back. Four of the six editors are associated with Western Reserve University.

Functional Anatomy of the Mammal. A guide to the dissection of the cat and an introduction to the structural and functional relationship between the cat and man. *W. James Leach.* McGraw-Hill Book Company, Inc., New York. Second edition, 1952. x+276 pp. $4.50.

The book is intended to be used with actual laboratory dissections by all students beginning work in anatomy.

Bacteria. *Stanley Thomas and Thomas H. Grainger.* The Blakiston Company, Philadelphia. viii+623 pp. $5.50.

A completely new text for an introductory course in bacteriology written from a biological point of view. The relationships of bacteria and allied organisms to their environment are stressed. A definitely workable key for classifying bacteria down to genera is included.

A Field Guide to the Butterflies of North America, East of the Great Plains. *Alexander B. Klots.* Houghton Mifflin Company, Boston. 1951. xvi+349 pp. $3.75.

This new handbook is an addition to the Roger Tory Peterson Field Guide Series. Its composition and illustrations follow the system which proved so successful with Peterson's *Field Guide to the Birds.* Besides bringing butterfly and skipper taxonomy up to date, the book includes much new life history and ecological information about these insects.